ELTEK

THEIA™ HE-t

String Inverter ~ 2.0 - 4.4 kW_{AC}, 600 V_{DC}

USER MANUAL

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IMPORTANT SAFETY INSTRUCTIONS!

SAVE THESE INSTRUCTIONS!

Safety Instructions

This *User Manual* contains important safety instructions for *THEIA HE-t UL* string inverters, which must be thoroughly read and followed prior to installation, operation and maintenance of the inverter. Ignoring these instructions may have serious consequences and may invalidate the warranty!

Qualified persons

Persons involved in installation, operation and maintenance of the inverter must be suitably qualified, and follow the instructions in this *User Manual*.

Safety Protection

The inverter offers a maximum level of safety to protect persons and equipment during installation, operation and maintenance. A high frequency transformer ensures galvanic isolation between the inverter and the grid. Anti-islanding protection monitors the grid preference and ensures interruption of the inverter's supply of power whenever the grid voltage or frequency fluctuations are outside the required limits. A Ground Fault Detection and Interruption circuit ensures disconnection from the grid if a ground fault occurs.

Warning Signs

Three different warning signs highlight important information related to avoidance of personal injury and equipment damage. Pay attention when ***DANGER***, ***WARNING*** and ***CAUTION*** appear in the text

Electrical Codes

The electrical installation must comply with the local regulations, the *National Electrical Code (NEC), ANSI/NFPA 70* and *OSHA* regulations.

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1. INTRODUCTION

The *THEIA HE-t UL* inverters are among the most efficient single phase grid-tie inverters on the market, which results in high yields from the solar array.

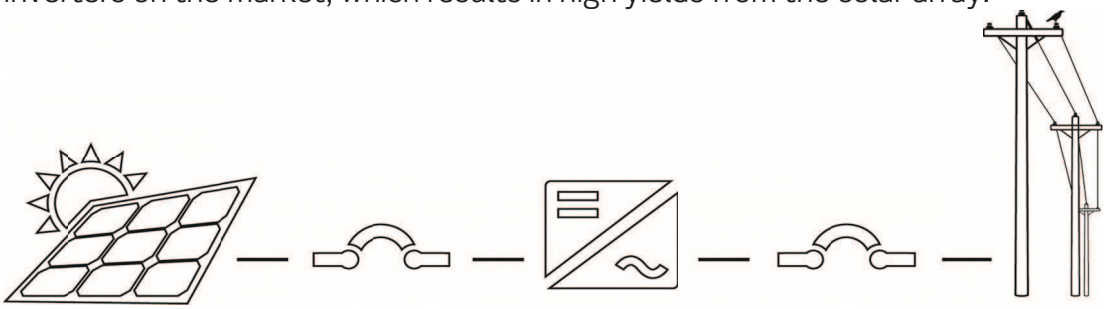


Figure 1.1: PV system overview

DC to AC

In a grid-connected photovoltaic system the interface between the solar array and the grid consists of an inverter, which converts DC power produced from the solar array into AC power compatible with the voltage and frequency of the grid.

THEIA HE-t UL series

The topology of the *THEIA HE-t UL* series consists of an embedded high-frequency transformer, which provides galvanic isolation from the grid thereby meets the strictest safety standards. Because of great adaptability and user friendliness, the *THEIA HE-t UL* is the perfect choice for any photovoltaic (PV) installation. Different configuration options make it suitable for crystalline as well as thin-film modules, and make it easy and affordable to configure for various conditions and country-specific requirements. The compact and lightweight construction provide for easy and straightforward installation and maintenance.

Integrated Web Server

The inverter is equipped with an integrated web server, which records data on a daily, monthly and yearly basis. All information is displayed alpha-numerically and in graphs on a colored LCD screen on the front of the inverter. The data is also accessible either directly from a PC or via the Internet. All settings and data are saved in the integrated logger, which provides storage of data with fifteen-minute intervals for one week, daily intervals for one year or weekly intervals for thirty years.

Automatic System

The system is fully automatic. The inverter starts up in the morning when the solar array generates enough power. During the day the maximum power point tracking

(MPPT) function ensures the highest possible energy harvest. The inverter goes into sleep mode at dusk when the solar array stops generating power.

2. PRODUCT OVERVIEW

This chapter gives an overview of the inverter with its supplied components and how they are assembled. A brief explanation of how to unpack and handle the inverter safely is given, and symbols appearing both on the inverter and in this *User Manual* are explained.

2.1. Standards and Approvals

THEIA HE-t UL inverters are compatible with most directives and safety standards, depending upon the grid settings chosen:

Table 2.1: Approved standards

Grid Protection	Safety	EMC
• IEEE 1547	• UL 1741	• FCC level B • IEC/EN 61000-6-2 (immunity) • IEC/EN 61000-6-3 (emission) • IEC/EN 61000-3-2/-12 (harmonics) • IEC/EN 61000-3-3/-11(flicker)

2.2. General Information

Several variations of the *THEIA HE-t UL* are available for different configurations and country-specific requirements.

2.2.1. Variants

The instructions given in this *User Manual* are applicable to the following range of *THEIA HE-t UL* solar inverters:

- *THEIA 2.0 HE-t UL*
- *THEIA 2.9 HE-t UL*
- *THEIA 3.8 HE-t UL*
- *THEIA 4.4 HE-t UL*

2.2.2. Options

- Negative or positive grounded system
- DC fuses

2.2.3. Key Features

- World's highest peak efficiency for isolated inverters: up to 97.3 %
- Flexible system configuration
- Monitoring 24/7
- Internal data logger with storage capacity of 15 minutes intervals for one week, daily intervals for one year or weekly intervals for thirty years
- MPPT range: 230 - 500V_{DC}
- DC voltage range: 220 - 600V_{DC}
- Automatic ON/OFF switching and temperature regulation
- Anti-islanding protection
- Reverse DC polarity protection (diodes)
- Ground Fault Detection and Interruption

2.3. Warning Symbols

The warning symbols used in this *User Manual* highlight **important information** on how to avoid hazards to people and equipment. **Pay particular attention when these symbols appear!**

Table 2.2: Symbols appearing in the manual

Symbol	Description
	DANGER: Situations where an immediate hazard could cause serious injury or death to workers and/or the general public if not avoided.
	WARNING: Situations where a potentially hazardous condition exists that could result in the death or serious injury of workers and/or the general public if not avoided.
	CAUTION: Situations where a non-immediate or potential hazard presents a lesser threat of injury that could result in minor or moderate injuries to workers and/or the general public.
	NOTICE: Situations where a non-immediate or potential hazard presents a risk to damage of property and equipment. May be used to indicate important operational characteristics. There is no "Safety Alert" or attention symbol present in this situation.

2.3.1. Labeling

2.3.1.1. Product Label

The product label is attached to the lower right side of the inverter housing. It contains important identification information and characteristics for the inverter, and must be clearly visible after installation.

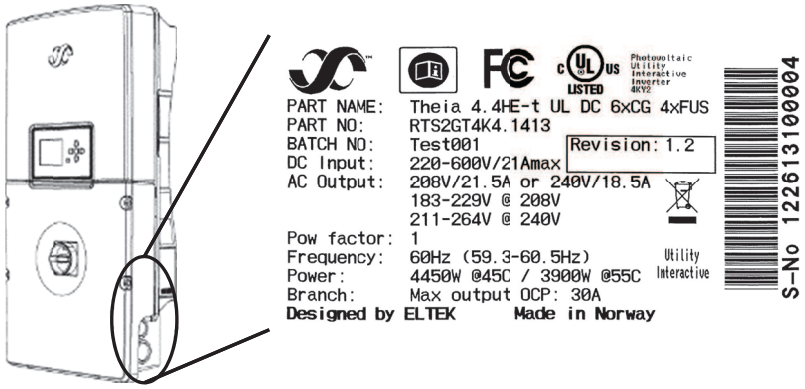


Figure 2.1: Product Label

Table 2.3: Symbols appearing on the product label

Symbol	Description
	Discharge time: High voltages may be present inside the inverter for 1 hour after switch OFF
	Refer to this *User Manual*: The safety precautions and instructions in this manual must be read and understood prior to installation
	Danger: Shock hazards – lethal voltages are present
	UL listing: The product meets the UL 1741 safety, health and environmental protection requirements.
	Disposal: Do not dispose in general waste! Collect the various parts separately and recycle them according to local regulations
	S – NO: Serial Number for inverter identification

2.3.1.2. PCB Labels

The PCB labels identify important information about the different terminals in the customer connection area.

Table 2.4: Symbols appearing on the PCB

Symbol	Description	Symbol	Description
~	**AC:** Alternating current terminal.	⎓	**DC:** Direct current terminal.
⏚	**Grounding:** Ground terminal.		

2.4. Unpacking and Inspection

Follow the instructions in this section to unpack and lift the inverter safely and to prevent injury and equipment damage.

2.4.1. Shipping Damage

The *THEIA HE-t UL* inverters are thoroughly checked and tested in accordance with international standards and approvals prior to shipping. The inverter is carefully packed before shipping. However, if any damage to the inverter is found when unpacking, please report it to your distributor immediately!

2.4.2. Lifting and Carrying the Inverter

Lifting and carrying the inverter must be correctly performed to prevent back injuries, as the inverters' weight is **49 – 53 lbs. / 22 - 24 kg** (depending on model).

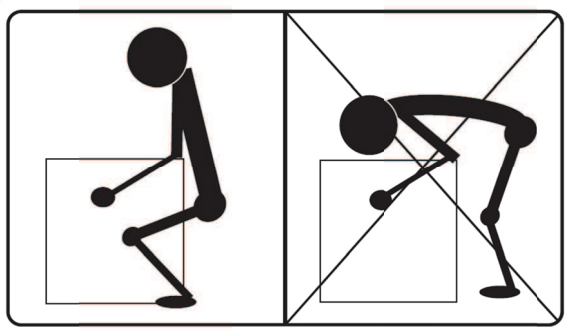


Figure 2.2: Correct lifting of the inverter

- When lifting, bend the knees, and keep the back straight.
- Lift carefully, hold the inverter close to the body and let the leg muscles do the work.
- Turn the whole body as one unit to avoid twisting the lower back.
- Carry the inverter close to the body.

2.4.3. Unpacking

Unpack the inverter as follows:

- Place the box in position, with the top clearly visible and according to the arrow markings on the packaging.
- Cut the seal, and open the box.
- Remove the upper part of the foam packing material and take out the *Installation Guide* and the envelope with the extra product label.
- Both sides of the inverter case are narrowed in order to get a better grip on the inverter. Lift the inverter carefully out of the box using the “handles” as illustrated in *Figure 2.3*.
- Remove the lower section of the foam packaging and take out the inverter mounting bracket.
- The bag with accessories is attached to the bracket.
- Store all the original packing material for possible later reuse.

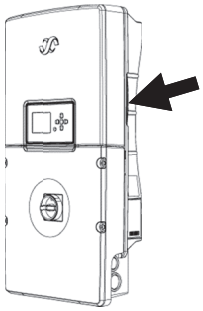


Figure 2.3: “Handles”

After unpacking the inverter, check that all components are included and undamaged.

2.4.4. Scope of Delivery

- *THEIA HE-t UL* single phase inverter
- Mounting bracket
- Installation Guide
- Accessories: grounding strap, bracket screws, extra product label

NOTICE

Conduits, fittings and bonding straps are not part of the standard scope of supply, and must be provided by the system installer.

2.4.5. Inverter Enclosure

The housing of the *THEIA HE-t UL* inverter is designed to:

- NEMA 3R or 4X (depending upon model) for indoor and outdoor use.
- Provide a degree of protection from falling dirt, rain, sleet, snow, windblown dust, splashing water, hose-directed water and corrosion.
- Be undamaged by the external formation of ice on the housing.

2.4.5.1. Mechanical Dimensions

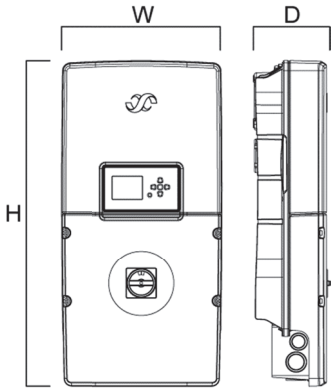


Figure 2.4: Mechanical dimensions

H: 28.3 inches / 720 mm
W:13.9 inches / 353 mm
D: 6.2 inches / 158 mm

2.4.5.2. Front Covers

The front surface of the inverter consists of an upper and a lower cover.

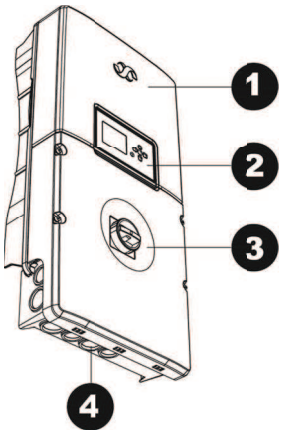


Figure 2.5: Inverter structure

1. Upper cover
2. Display
3. Lower cover with DC disconnect switch
4. Hole covers (Knockouts)

The upper cover may be removed by *Eltek* authorized persons **only**. Removal of the upper cover by unauthorized persons voids the warranty!
The lower cover protects the customer connection area, and may be removed by the system installer for electrical connection and maintenance.

2.4.6. Removing the Lower Cover

The lower cover protects the connection area in the inverter and also the inbuilt combiner box called the Stringbox. The lower cover is equipped with a DC switch on the front, which make it easy to de-energize the DC terminals on the inverter.

WARNING

The inverter is charged with high voltages, and removal of the lower cover may only be performed by qualified persons.

1. Turn **OFF** the AC circuit breaker and the DC - switch.

DANGER

Always disconnect the PV array cables from the inverter after turning the AC and DC **OFF**, but before removing the covers, as the PV array can supply up to 600 V_{DC} to the inverter when exposed to sunlight.

2. Remove the four screws on the front with a 4 mm hex key.
3. Angle the cover outwards, and take it off carefully.

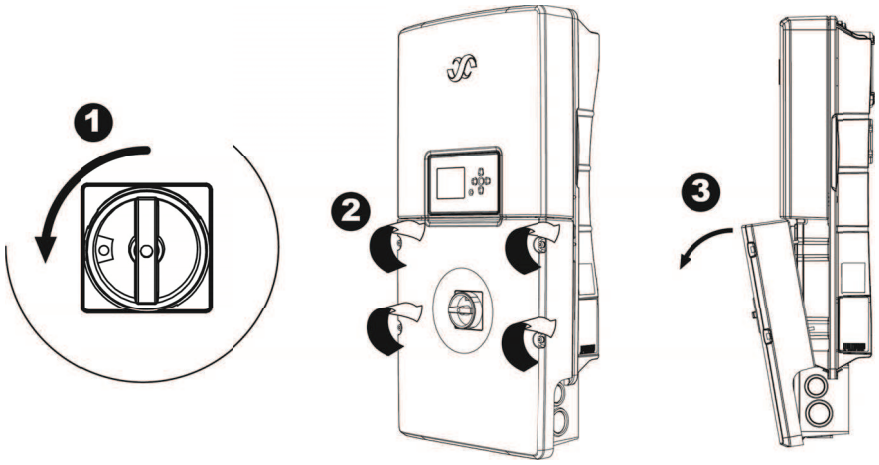


Figure 2.6: Removing the lower cover

4. Store the lower cover and screws safely to avoid loss or damage.
5. Fasten the screws on the lower cover with a torque of 0.74 ft-lbf / 1.0 Nm.

CAUTION

Never remove the inverter lower cover in wet conditions! Removal of the inverter lower cover during rain or in damp conditions can damage sensitive internal electronic components.

3. SAFETY PRECAUTIONS

This chapter contains instructions on how to install, operate and maintain the *THEIA HE-t UL* inverters safely. These safety precautions must be read thoroughly and understood prior to installation. Failure to follow the safety precautions may result in injury or death and may void the warranty.

3.1. General Preparations

The *THEIA HE-t UL* inverters contain no user-serviceable parts, and **installation and maintenance must be performed by qualified persons**, who have knowledge of state and federal electrical regulations ANSI/NFPA 70 NEC and *OSHA,* and follow such regulations, and the instructions in this *User Manual*.

NOTICE

The safety precautions and instructions in this *User Manual* must be read thoroughly to be able to install and operate the inverter correctly.

3.1.1. Connections

Contact the local utility company for interconnection agreements and power approval before connecting to the grid.

WARNING

To ensure safe and correct electrical connection of the inverter and prevent injury to persons or damage to the equipment the electrical wiring and connection must be performed by **qualified persons**.

DANGER

Never work with energized ports! Prior to the electrical connection, the AC circuit breaker(s) and the DC switch must be turned OFF to ensure that the terminals are discharged and safe to work on.

- Read the instructions and cautions on the PV modules prior to the electrical connection.
- The inverter must be connected to a dedicated AC circuit. No other devices are to be connected to this circuit.

3.1.2. Operation

The inverter must only be operated in accordance with the instructions in this *User Manual*.

NOTICE

The *THEIA HE-t UL* is a grid interactive inverter and must be used exclusively for its designed purpose, which is to convert PV-generated DC electricity into AC electricity to feed into the grid.

- The inverter must be operated without any unauthorized modifications.
- To avoid damage to the inverter, it must be used within the operational limits given in the technical specifications.

CAUTION

Keep the voltage and current within the specified limits! The voltage generated by PV modules is inversely proportional to the temperature; at lower temperatures the PV voltage increases from the product label rating and at higher temperatures the PV voltage decreases from the product label rating.

NOTICE

The open circuit voltage, V_{OC}, must never exceed $600V_{DC}$ under any conditions. The maximum PV system voltage is equal to the sum of the rated open-circuit voltage, of the series-connected PV modules, corrected for the lowest expected ambient temperature.

- Misuse of the inverter may damage the device or other electrical equipment and can interfere with the operation of the inverter, or may even cause injury or death to persons operating and maintaining the inverter.
- Ignoring the instructions and guidelines in this *User Manual* and not performing regular maintenance may void the inverter warranty.

3.1.3. Maintenance

Prior to service and maintenance, the inverter **must always be disconnected** on both the AC and the DC sides and **be fully discharged**. Refer to *8.1. Switch-OFF*.

NOTICE

Accessing the inverter upper section voids the warranty. The inverter upper cover must only be opened by authorized persons due to danger of damage to internal components.

- The inverter lower cover must only be taken off by qualified persons during the electrical installation and maintenance or repairs.
- No unauthorized modifications may be made to the inverter. Contact the system installer or distributor in case of failure.
- Regular maintenance must be performed to maximize the life expectancy of the inverter (refer to *8.2. Regular System Inspections*).
- A safety component must always be replaced by the same type and rating.

3.2. Site Preparations

Observe the following precautions when mounting and installing the *THEIA HE-t UL* inverter on a suitable site. This is crucial to maintain the efficiency of the inverter!

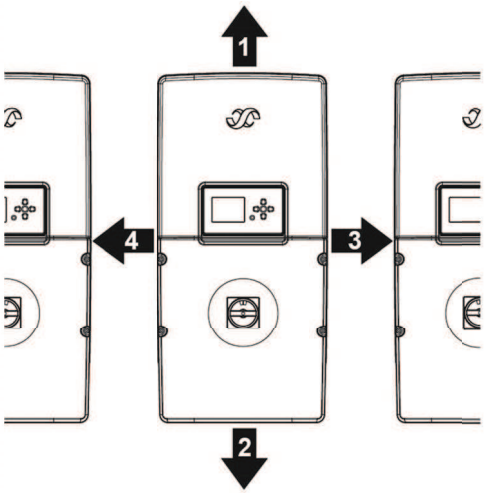
3.2.1. Mounting Location

Sufficient ventilation and low ambient temperature are needed to prevent temperature build-up inside the inverter, which can result in power losses.

CAUTION

Insufficient cooling may lead to degradation of performance! Ensure sufficient air space around the inverter and unblocked ventilation openings for optimum cooling and efficient operation.

- Observe the minimum distances specified below to maintain optimal cooling:



1. 15.75 inches / 400 mm
2. 11.81 inches / 300 mm
3. 5.91 inches / 150 mm
4. 5.91 inches / 150 mm

Figure 3.1: Minimum distances for optimum cooling

WARNING

The mounting surface must be suitable for the weight (44-49 lbs/20-22 kg) and temperature (194°F /90°C) of the inverter.

- The inverter must be mounted in a vertical position.
- Keep the lower cover closed when mounting the inverter to avoid damage to internal components.
- It is not recommended to install the inverters in living areas due to possible noise levels of the inverter.
- The display should be at eye-level, the product label must be visible and the connection area readily accessible.

3.2.2. Environment

The installation of the inverter must comply with local regulations, the *National Electrical Code* and the *OSHA* regulations.

WARNING

Protect the inverter from flammable and explosive environments to avoid fire, as the inverter heat sink can reach temperatures as high as 194°F/90°C during long periods of high performance operation.

- Ensure a longer life and optimum performance of the inverter by installing it in a clean, non-dusty, dry and cool environment
- Ensure a non-flammable and non-explosive environment to avoid fire.

- The ambient temperature must be between -13°F and 140 °F/-25 °C and +60 °C. If the temperature rises above 104°F/+40°C the inverter may start to reduce power to protect internal components.
- It is recommended that non-condensing relative humidity should be between 4 % and 95 %.

NOTICE

Avoid exposing the inverter to direct sunlight! Direct sunlight may cause yield losses, as direct sunlight causes increased internal temperature that can lead to reduced power output. Also, direct sunlight may cause degradation of the LCD screen quality.

CAUTION

The inverter should be installed on a location where people cannot accidentally come in contact with the rear inverter surface, due to temperatures up to 194°F/90°C.

- The inverter is suitable for outdoor operation, but should be sheltered from direct sunlight, snow and rain, dust and sand.
- Inverter location should be in close proximity to the PV arrays to minimize DC losses.

3.3. Required Safety Equipment

Compliance with the local and federal electrical regulations is required to satisfy the safety equipment requirements.

NOTICE

Safety equipment must be provided and installed by the system installer in compliance with *NEC* to ensure the required protection of the PV system is adequate.

3.3.1. Disconnection Devices

Disconnection devices, **switches or circuit breakers**, enable a shut-off from the power source during operation. They protect the current-carrying conductors and other system components from power surges and system malfunctions, and help to shut down the inverter safely for maintenance and repairs.

- Both AC circuit breaker(s) and DC switch are recommended on every current-carrying conductor to facilitate maintenance work and repairs of the inverter.

- The disconnect devices must conform to the local and federal electrical regulations, and have an interrupt rating sufficient for the voltage and current available in the circuit.
- Each disconnection device must be readily accessible and totally enclosed. All devices must be permanently marked for their purpose.

3.3.2. Overcurrent Protection Devices

Overcurrent protection devices, **fuses or circuit breakers,** protect the circuit conductors and prevent overheating as a result of overload, short circuit or ground fault.

- An overcurrent protection device is required on each ungrounded conductor.
- If a fuse blows or a circuit breaker trips, the cause should always be determined before replacing or resetting it.

3.3.2.1. Ground Fault Protection (GFDI)

- The GFDI protects the negative/positive grounded strings from ground faults in the PV array or in the PV conductors. It is located in the lower compartment of the Stringbox and is equipped with a finger-safe fuse holder.
- If the ground fault current exceeds 1A the GFDI opens and the inverter shuts down (Refer to *7.2. Table of Events*).
- The rating of the GFDI is 600V_{DC} and 1A.

3.3.2.2. DC Fuses

- DC fuses protect the conductors from back feed currents from parallel strings. They are located in the Stringbox, equipped with finger-safe fuse holders to disconnect each fuse independently.
- The rating of the DC fuses should be as per the recommendations of the PV module manufacturer, UL requirements and *NEC*, with a maximum of 40 A.
- DC fuses are normally not a part of the scope of delivery, and must be provided by the system installer. *Eltek* may supply DC fuses, if they are specified at the time of order.

Table 3.1: DC current characteristics and recommended fuse ratings

Inverter Type	Max DC Current	1x PV String Fuses	2x PV String Fuses	3x PV String Fuses
THEIA 2.0HE-t UL	9.5A	15A	8A	5A
THEIA 2.9HE-t UL	13.5A	22A	11A	8A
THEIA 3.8HE-t UL	18.0A	29A	15A	10A
THEIA 4.4HE-t UL	21.0A	33A	17A	11A

NOTICE

Overcurrent protection is not required for PV strings where the maximum current, which is equal to 1.25 x I_{SC}, from all sources cannot exceed the ampacity of the PV string conductors or the maximum overcurrent device size specified on the PV module product label.

3.3.2.3. AC Overcurrent Protection

- The AC Overcurrent Detector (OCD) protects the supply conductors between the inverter and the grid.
- AC OCD must be provided by the system installer.

CAUTION

To reduce the risk of fire, the inverter AC terminals must only be connected to a circuit provided with branch circuit overcurrent protection in accordance with the National Electrical Code, ANSI/NFPA 70, and having maximum ratings as per ***Table 3.2*** below

Table 3.2: AC current characteristics and fuse rating

Inverter Type	Max AC Current		AC Fuses		Tripping Characteristics	Type
	208V_{AC}	**240V_{AC}**	**208V_{AC}**	**240V_{AC}**		
THEIA 2.0HE-t UL	10.0A	8.5A	15A	15A	B or C	Double Pole
THEIA 2.9HE-t UL	14.0A	12.0A	20A	15A		
THEIA 3.8HE-t UL	18.5A	16.0A	25A	20A		
THEIA 4.4HE-t UL	21.5A	18.5A	30A	25A		

3.3.3. Surge Protection

Overvoltage protection is used to prevent voltage surges through sensitive equipment. The *THEIA HE-t UL* inverters are equipped with *Temperature protected Metal Oxide Varistors (TMOV)* on both the DC source current and the AC output current, which diverts the excessive current from voltage surges to ground.

- PV systems installed in an open or exposed environment need added protection on both the DC and AC sides, as they can act as lightning rods.
- When the conductors are exposed to transients, their behavior limits the effectiveness of a surge arrester. One or more surge arresters are needed in installations with long conductors to obtain the required level of protection.
- Refer to NEC guidelines for selecting appropriate kA ratings for overvoltage protection devices.
- *IEEE* provides a good base for selecting kA ratings of the surge arrester: The *THEIA HE-t UL* inverters are designed for category B: 100 kA – 150 kA per phase.

4. INSTALLATION

This chapter describes how to install the inverter correctly, both mechanically and electrically, and details important issues related to the installation. **The information is intended for qualified persons** who follow the installation instructions as described in this *User Manual*.

DANGER

Never work with energized ports! All work on the inverter must be performed with the terminals disconnected.

NOTICE

The *Safety Precautions* (refer to *3. Safety Precautions*) and the following detailed installation procedures must be read carefully prior to installation.

4.1. Mechanical Installation

The mounting surface and the mounting method must be suitable for the inverter's weight, dimensions and housing temperature (Refer to *10. Technical Data*).

WARNING

Following the installation instructions will prevent poor performance or possible lethal consequences.

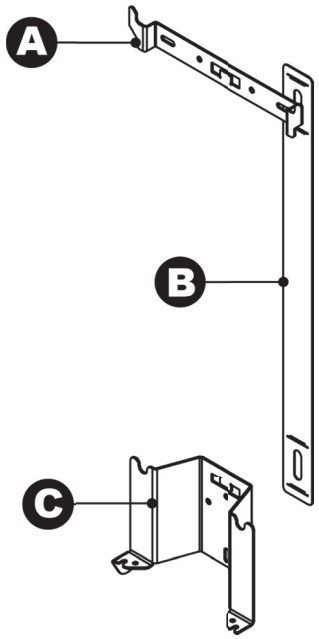
4.1.1. Wall Bracket

Depending on the mounting surface, different mounting methods may be required to secure the wall bracket. The **system installer** is responsible for selecting the correct type and number of fasteners to support the weight of the inverter on the mounting surface.

- The bracket is designed to support 176.4 lbs. / 80 kg.
- The inverter must be mounted in a vertical orientation!
- Mount the inverter in compliance with the minimum spacing to ensure optimum cooling (Refer to *3.2.1. Mounting Location*). This is especially important with several inverters installed.
- The recommended height for the connection area is 40 - 55 inches /1000-1400 mm above floor level.

Assembling

The bracket consists of three parts:



A. Inverter Bracket
B. Spacer (Optional)
C. Stringbox bracket

Figure 4.1: Wall bracket components

Assemble the bracket as follows:

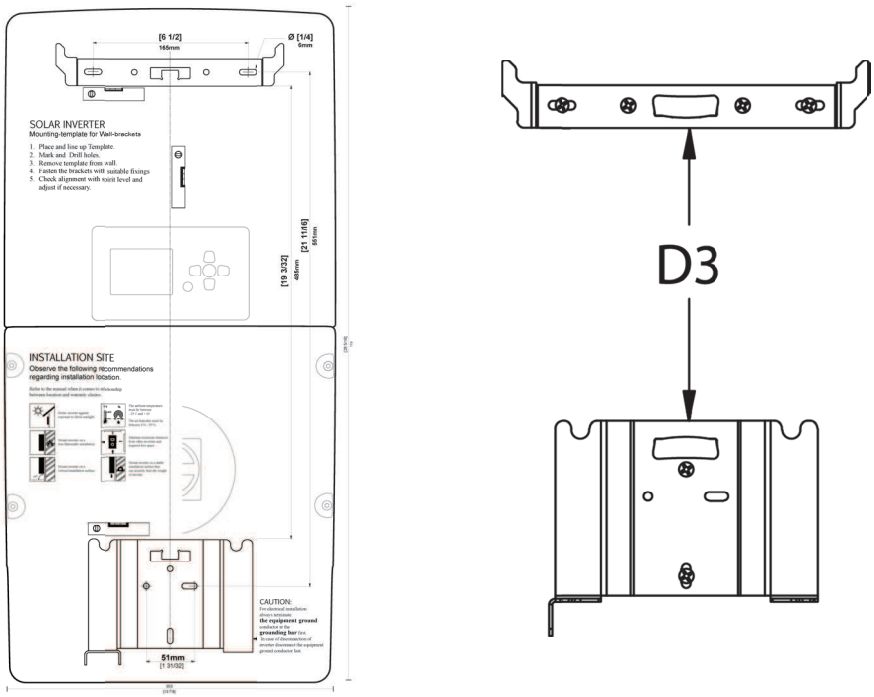


Figure 4.2: Assembling of the wall bracket

1. Fix the drilling template onto the mounting surface, and using a spirit level ensure the template is correctly leveled.
2. Using the guide holes on the drilling template, drill holes into the mounting surface suitable for ¼ inch fixings of a type relevant to the mounting surface, and weight of the inverter.
3. Remove the drilling template from the mounting surface.
4. Fasten the inverter bracket to the wall with a minimum 2 screws. The installer is responsible for selecting the correct dimension of the screws. The holes in the bracket have a diameter of ¼ inch.
5. The correct distance between the inverter bracket and the Stringbox bracket is: **D3** = 19 $^{1}/_{8}$" (+ $^{45}/_{64}$"). Fasten the Stringbox bracket to the wall with minimum 2 screws. The holes in the Stringbox bracket have a diameter of ¼ inch.

The distances between the screws:

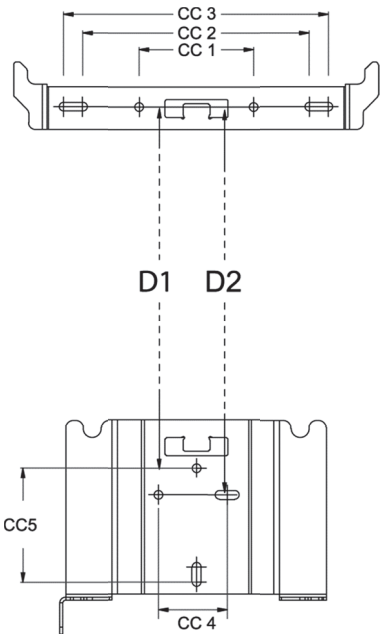


Figure 4.3: Distances between the fasteners

CC1: 3"
CC2: 6"
CC3: 7"
CC4: 2"

CC5: 3"
D1: 21" (+ $^{45}/_{64}$" – 0")
D2: 21 ¾" (+ $^{45}/_{64}$" – 0")

4.1.2. Inverter

Attach the inverter to the mounting bracket as follows:

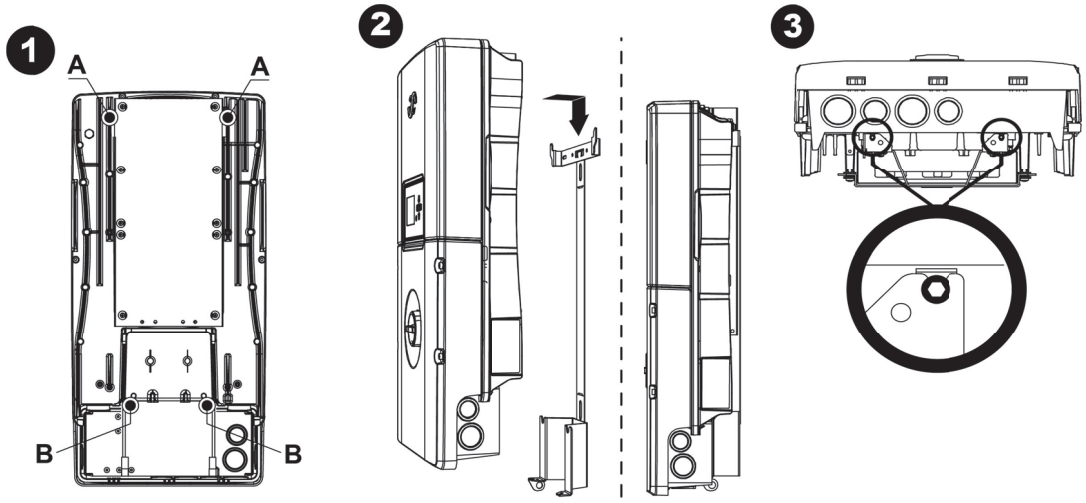


Figure 4.4: Fasten the inverter to the bracket

1. Locate the hooks for the carrier slots (A) on the upper back of the inverter and the locating pin taps on the Stringbox (B).
2. Lift the inverter and guide the upper hooks into the slots on the inverter bracket. Align the lower taps into the slots and slide the inverter onto the bracket.
3. Ensure that the inverter is securely aligned in the bracket rails, and fasten the inverter with 2 screws on the bottom of the Stringbox. Recommended tightening torque is 0.74 ft-lbf / 1.0 Nm.

NOTICE

Check that the inverter is properly fastened and secured to the bracket prior to the electrical wiring.

4.2. Checks Prior to Electrical Installation

- ☑ Make sure that both the AC circuit breaker(s) and the DC switch are OFF and that the terminals are in a discharged state to prevent shock hazards during the installation of the inverter. Refer to *8.1. Switch-OFF*.
- ☑ All electrical installations shall comply with the current local and federal electrical regulations.
- ☑ Check that the PV and the grid specifications are compatible with the inverter specifications. Refer to *10. Technical Data*.
- ☑ Check that the inverter is properly fastened and secured to the bracket.
- ☑ Ensure that the conductors are listed for PV applications and the site environment, and that they have the correct color coding.

☑ Ensure that the electrical installation complies with the local and national electrical regulations in force at the installation site.

4.3. Electrical Installation

Correct electrical connection is critical for achieving safe, long-term and reliable operation of the entire PV system.

NOTICE

The electrical connections must be performed by **qualified persons** and comply with local and federal electrical regulations and the instructions detailed in this *User Manual.*

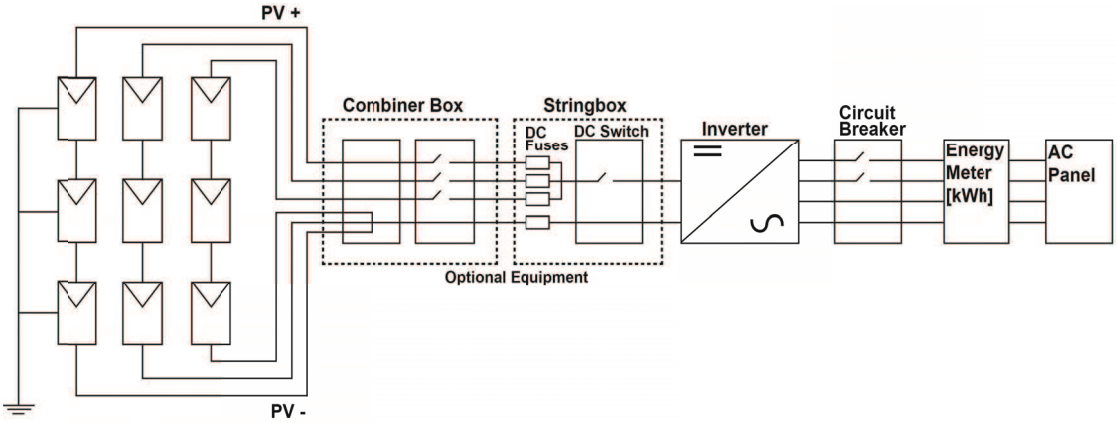


Figure 4.5: Simplified system overview

4.3.1. Conductors

Two important criteria must be considered in selection of conductor sizes, namely ampacity and voltage drop. Using correctly sized conductors improves the efficiency of the PV system.

- **Ampacity** refers to the current-carrying capacity of the conductor. The larger the conductor is, the greater its capacity to carry current.
- **Voltage drop** is the reduction of voltage due to cross section, current flow and length of the conductor. It is recommended to minimize the system conductor voltage drop. Voltage drop is equivalent to loss in energy yield

CAUTION

The conductor cross section area must conform to the ratings of the NEC standards to prevent overheating and fire.

- Use adequately sized conductors with the correct temperature rating and sunlight resistance.
- Secure conductors so that they are kept away from objects that can damage the insulation (e.g. sharp edges).

CAUTION

The conductors must be listed for PV applications and the site environment and have the correct color coding to avoid material damage and bodily harm.

4.3.2. Connection Area

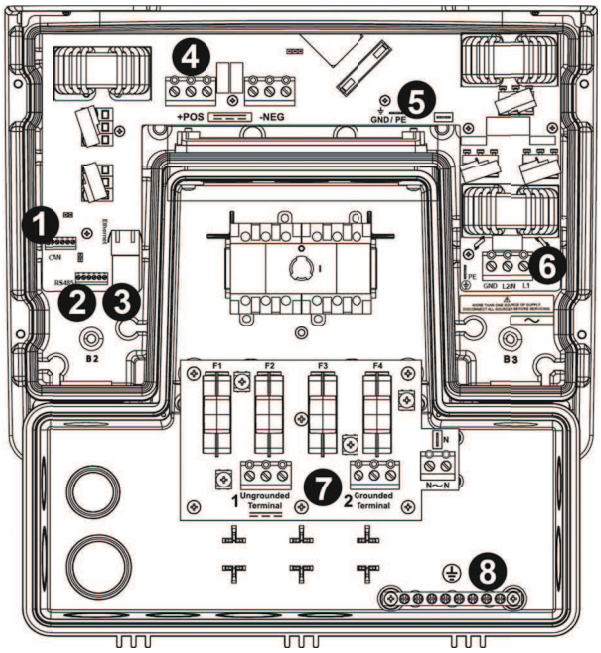


Figure 4.6: Customer connection area

1. CAN bus terminal
2. RS-485 terminal
3. Ethernet connection
4. Internal DC terminal blocks, ***+POS*** and ***-NEG***
5. Internal DC ground terminal, ***GND/PE***
6. Internal AC terminal block
7. DC fuse board, Stringbox
8. Equipment grounding bar, Stringbox

- **DC connection** can be either a negative or positive grounded PV string configuration.
- **AC connection** is performed differently depending on the grid configuration.
- **Network connections** are the same regardless of the different DC and AC connection options.

4.3.2.1. Conduits

The *THEIA HE-t UL* inverter Stringbox is equipped with covered holes (knockouts) to fit the recommended conduit fittings.

- The Stringbox connected to the bottom of the inverter is made of non-conductive material and shipped with knock outs for ¾" and 1" conduit fittings.
- The knock outs are located on the left and right sides, bottom and back of the Stringbox as specified in the figure below.
- It is recommended to use a hole saw to remove the knockouts, to ensure the hole is even for fixing of the conduit.

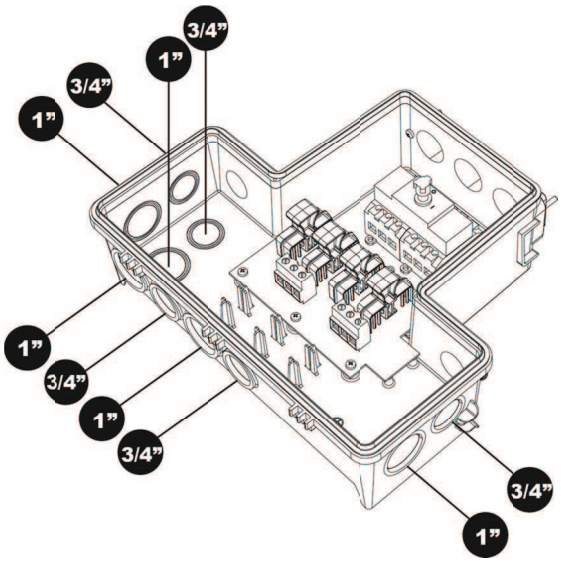


Figure 4.7: Knock outs on the Stringbox

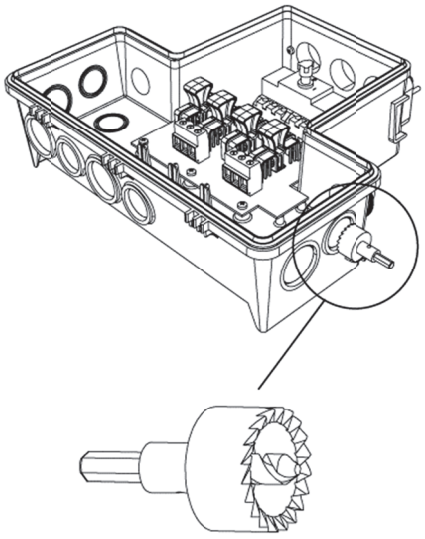


Figure 4.8: Removal of the knock outs

- Use a 1" hole saw to remove the knock outs for the ¾" fittings and 1-$^{5}/_{16}$" hole saw to remove the knock outs for the 1" fittings.
- Position the hole saw in the middle of the knock out face.
- Drill through the cover.
- Carefully file down any rough edges.

NOTICE

For conduit hubs, use only UL Listed raintight, or wet location, hubs for entry into the enclosure

Conduits are connected to the Stringbox as follows:

- **DC** conduits are mounted on the **bottom** of the Stringbox.
- **AC** conduits are mounted on the **right side** of the Stringbox.
- **Network** conduits are mounted on the **left side** of the Stringbox.

Listed conduit fittings that fulfill the following criteria should be used for the *THEIA HE- t UL* Stringbox knock outs:

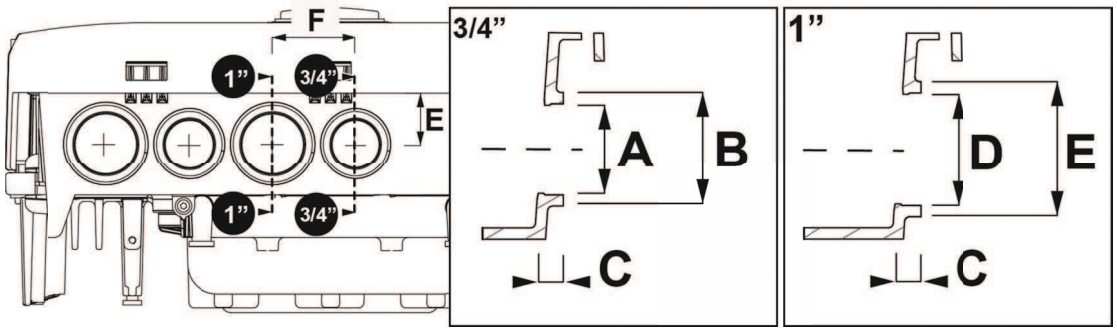


Figure 4.9: Size criteria for conduits to fit the Stringbox knock outs

Table 4.1: Recommended size for the conduits

Symbol	Size
A	$1\ ^{1}/_{9}$” / 28.8 mm
B	$1\ ^{3}/_{7}$” / 35.8 mm
C	$^{2}/_{7}$” / 7.0 mm
D	$1\ ^{3}/_{7}$”/ 35.5
E	$1\ ^{9}/_{14}$” / 42.5 mm
F	$1\ ^{11}/_{14}$” / 45.3 mm

NOTICE

Follow the guidelines from the conduit manufacturer regarding connection, grounding and tightening torque.

4.3.3. Grounding

Proper grounding of the entire PV system limits voltage surges, gives a common reference point for the conductive parts and facilitates the operation of the overcurrent protection devices.

DANGER

Grounding should be carried out by qualified persons only, and comply with local and national electrical regulations to prevent shock hazards.

- The AC input and AC output circuits are isolated from the enclosure and that system grounding, if required by Section 250 of the National Electrical Code, ANSI/NFPA 70, is the responsibility of the installer
- The Photovoltaic System Grounding shall be installed per the requirements of Sections 690.41 through 690.47 of the of the National Electrical Code, ANSI/NFPA 70 and is the responsibility of the installer
- PV strings may have the negative or the positive conductors grounded. The **grounded conductors** are terminated at the ***equipment grounding bar*** in the Stringbox via the GFDI (*Figure 4.6, pos. 8*).

- All **metallic conduit fittings** shall also be bonded to the ***equipment grounding bar*** in the Stringbox (*Figure 4.6, pos. 8*).
- Follow the instructions and specifications from the different PV module manufacturers regarding grounding requirements.
- All metal parts of the *THEIA HE-t UL* inverters are electrically bonded to ground through the terminal ***GND*** at the AC terminal block (*Figure 4.6, pos. 6*).

CAUTION

Grounded PV conductors are grounded via the GFDI to the grounding bar in the Stringbox and must **NOT** be grounded at any other point in the system, as voltage potentials can appear and possibly damage electrical components.

4.3.4. DC Connections (PV)

The DC connections include wiring from the PV modules through a combiner box to the inverter. The inverter is configured with a Stringbox.

DANGER

Always disconnect the PV array before starting the DC connections, as the PV array can supply up to 600 V_{DC} to the inverter when exposed to sunlight.

NOTICE

When removing the lower cover to access the connection terminals ensure that the DC switch is in the OFF position.

4.3.4.1. DC Terminals

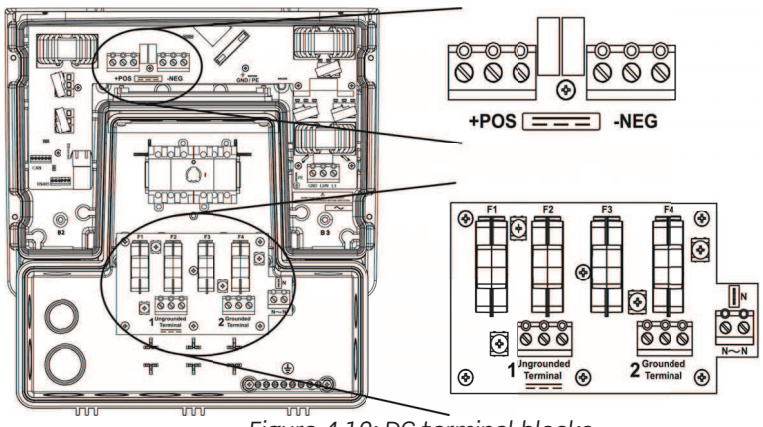


Figure 4.10: DC terminal blocks

The incoming PV conductors shall be terminated at the ***1.Ungrounded Terminal*** and ***2.Grounded Terminal*** inside the Stringbox.

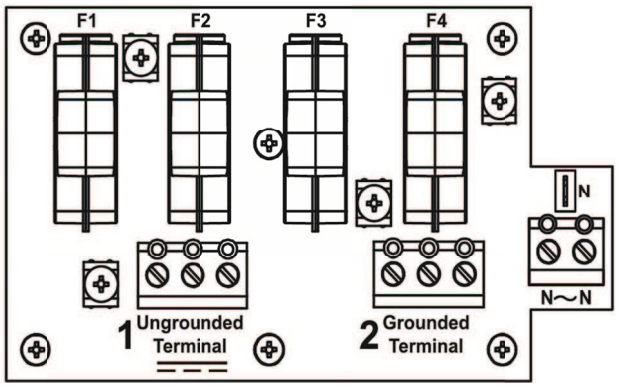


Figure 4.11: Fuse board in the Stringbox

F1, F2, F3: DC fuse holders.
F4: Ground fuse holder (GFDI).
1. **Ungrounded Terminal:** Terminal block for the ungrounded PV conductors.
2. **Grounded Terminal:** Terminal block for the grounded PV conductors.

N: Receptacle for monitoring the voltage between phases and neutral.
N-N: Terminal block for the neutral conductor.

The PV conductors go through the DC switch in the Stringbox, and are then terminated at the ***+POS*** and ***–NEG*** terminal blocks in the lower inverter compartment.

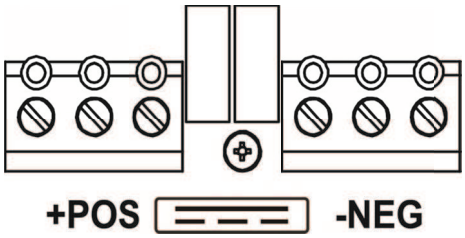


Figure 4.12: Terminals in inverter lower compartment

+POS: Positive terminal block
-NEG: Negative terminal block

NOTICE

The connection requires removal of the inverter lower cover, and must be performed by **qualified persons** only!

4.3.4.2. Array Configuration

A PV string consists of a certain number of PV modules connected in series. Strings can be connected in parallel forming an array and attached to the inverter. The *THEIA HE-t UL* inverters have a large voltage range, and several feasible PV string configurations are possible. Follow the *NEC* and the module manufacturer instructions when configuring the PV array!

- The **grounding configuration** of the PV array and the connection to the DC terminals depend on the module technology.

- The inverter is delivered from the factory with a **negative grounded PV array configuration** as a standard, but may also be delivered for a **positive grounded PV array configuration**.
- The **positive grounded PV array configuration** differs from the negative grounded PV array configuration by the connection to the DC terminal blocks in the inverter lower compartment and in the Stringbox and the DC switch in the Stringbox.

- **Array configuration** depends on the module technology used. Both the positive and negative DC terminal blocks have three pairs of inputs, which allow three strings to be connected in parallel. Due to the inverter having **one MPP-tracker** the **PV power** should be identical for every string.

NOTICE

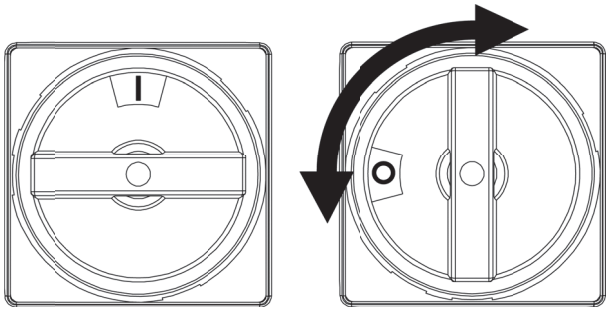
Maximum Voltage: The open circuit voltage, V_{OC}, must never exceed 600 V_{DC} under any conditions. The voltage generated by PV modules is inversely proportional to the temperature; at lower temperatures the PV voltage increases from the nameplate rating and at higher temperatures the PV voltage decreases from the nameplate rating.

4.3.4.3. DC Switch

The Stringbox is attached to the bottom of the inverter, and provides PV string connection via the wiring that runs from the PV array. A DC disconnect switch is provided and mounted in the Stringbox.

NOTICE

Before removing the lower cover to access the connection terminals ensure that the DC switch is in the **OFF** position, and the PV array cables are disconnected.



I = ON
0 = OFF

Figure 4.13: DC disconnect switch

The DC switch is rated at:
600Vdc
25A

4.3.4.4. Positive Grounded PV String

The inverter is shipped with a negative grounded string configuration, if nothing else is specified at the time of order. The difference between negative and positive grounded PV configurations is the connection to the ***Ungrounded*** and ***Grounded*** terminal blocks in the Stringbox and the ***+POS*** and ***–NEG*** terminal blocks in the inverter lower compartment.
The figure below shows the difference between negative and positive grounded strings.

Negative Grounded PV String

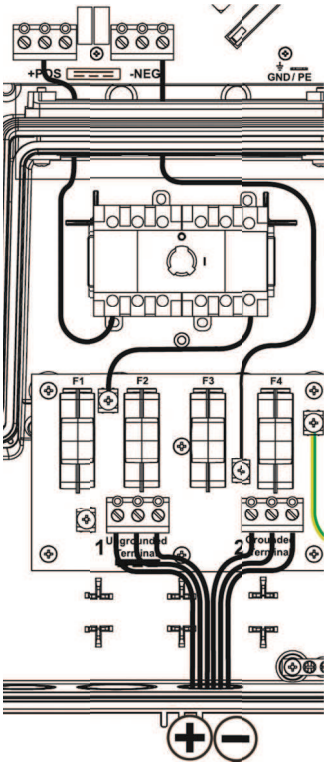


Figure 4.14: Negative grounded PV string

Positive Grounded PV String

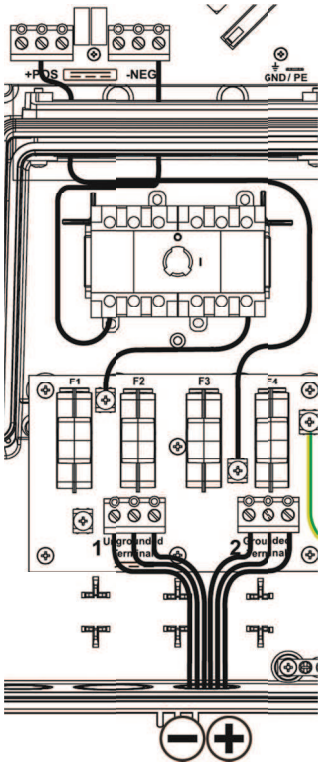


Figure 4.15: Positive grounded PV string

To change from Negative ground to Positive ground:

- Terminate the **positive** conductors at the terminal block labeled ***2. Grounded*** in the Stringbox.
- Terminate the **negative** conductors at the terminal block labeled ***1. Ungrounded*** in the Stringbox.
- Terminate the **grounded** positive conductor from the fuse board at the **+POS** terminal block in the inverter lower compartment.
- Terminate the **ungrounded** negative conductor from the DC switch at the ***-NEG*** terminal block in the inverter lower compartment.
- Tightening torque is 1.47 ft-lbf / 2.0 Nm for all terminals.

4.3.4.5. Connection Procedures

- The DC voltage on the conductors connecting the PV array to the input of the inverter must have a maximum rating of 600V_{DC} at any operating temperature.
- The DC conductor must be sized for correct temperature rating and sunlight resistance. Use copper conductors between 10 AWG and 6 AWG / 6 mm^2 and 16mm^2 and temperature rating of 194°F / 90°C for all connections.
- Follow the safety instructions and specifications from the module manufacturers regarding installation.
- Terminate the **ungrounded** conductors at the terminal block labeled ***1. Ungrounded***, and tighten the screws by applying 1.11 ft-lbf / 1.5 Nm of torque.
- Terminate the **grounded** conductors at the terminal block labeled ***2. Grounded***, and tighten the screws by applying 1.11 ft-lbf / 1.5 Nm of torque.

NOTICE

PV systems with GFDI that incorporate the system grounding connection must not have an additional grounding connection.

4.3.4.6. Reversed DC Connection

If the positive and negative terminals are reversed during connection, the inverter will not start. The inverter will not be damaged due to internal reverse blocking diodes, but high currents are generated in the conductors.

DANGER

Be aware of high currents! If the DC terminals are reversed during installation, high currents are generated in the conductors, which can pose shock hazards.

Procedure

- Turn OFF the AC circuit breaker(s) and the DC switch.

DANGER

The PV conductors are still charged after the DC switch on the Stringbox is turned OFF, due to power feeding PV modules. Always turn OFF the remote DC switch and wait until the PV modules do not feed power.

- Remove the PV connectors
- Check if the terminals are discharged by using a voltmeter.
- Disconnect the conductors from the terminal block.

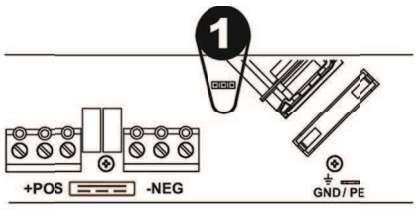
- Reconnect the conductors to the correct terminal block.
- Test the polarity using a voltmeter before turning ON the DC switch and the AC circuit breaker(s).

4.3.4.7. Jumper Position for System Grounding Setup

The jumper above the ***- NEG*** terminal block in the inverter lower compartment monitors the arrangement of the DC connection according to the grounding setup. The jumper is positioned for a **negative grounded PV string** configuration. Depending on the grounding requirements from the module manufacturer the jumper must be repositioned.

In case of a mismatch in grounding setup the following message will appear in the display: "*Fuse fault*". Refer to *7.2 Table of Events*

Table 4.2: Jumper position for the DC grounding configuration

Inverter lower compartment	Top view	System
 ***1.*** *Jumper monitoring the grounding setup.*		**Negative grounded PV configuration:** The jumper short-circuits the two rightmost pins (*default*).
		Positive grounded PV Configuration: The jumper short-circuits the two leftmost pins.

4.3.5. AC Connections (Grid)

The AC connection includes wiring from the AC distribution panel through one or more circuit breakers to the AC terminal block of the inverter (refer to *4.3.2 Connection Area*).

Verify that the AC grid parameters are compatible with the inverter specifications before connecting the inverter to the grid:
- Single phase $240V_{AC}/120V_{AC}$
- Single phase $208V_{AC}/120V_{AC}$ WYE
- Frequency range: 55.0 to 63.0 Hz

NOTICE

The *THEIA HE-t UL* inverter provides a voltage output range from 184 V_{AC} to 276 V_{AC}.

CAUTION

The AC output / Neutral of the inverter is not bonded to ground.

WARNING

To reduce the risk of fire, do not connect to an AC circuit breaker panel having multi-wire branch circuits connected.

DANGER

Turn OFF the AC circuit breaker(s) and the DC switch before connecting the inverter to the grid to prevent electrocution.

AC power systems are found in both commercial/industrial and residential/office applications. Phase power systems usually have three conductors:

Table 4.3: The different AC conductors

Term (Abbr.)	Description
Phase conductor (*L1/L2*)	The ungrounded conductors, which carry current to the load.
Neutral conductor (*N*)	A circuit conductor carrying the unbalanced current of the ungrounded conductors.
Equipment ground conductor (*GND*)	An electrical path to ground, designed to carry fault current.

These three conductors are connected to the service entrance panel. The typical 120 V_{AC} single phase is provided by connection of either ***L1*** and ***N*** or ***L2*** and ***N***. ***L1*** and ***L2*** provide 240 V_{AC} while ***L1*** and ***N*** or ***L2*** and ***N*** provide 120 V_{AC}.

120 V_{AC} loads must be distributed evenly between ***L1*** and ***L2*** to keep the system in balance. Also, by connecting to a three-phase system the load must be distributed evenly between the three phases.

NOTICE

Single phase inverters connected to a three phase primary power source must not significantly increase unbalanced system voltages.

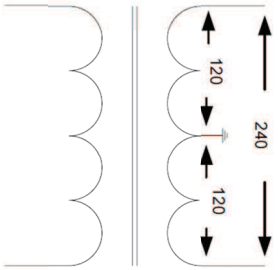
4.3.5.1. Connection Procedures

Depending on supply voltage configuration the connections to the inverter must be performed differently.

- The current carrying conductors on the AC side must be rated for the current and be maximum 6 AWG /16 mm^2. Ensure compliance with electrical regulations!
- The current carrying conductors on the AC side must be rated for the appropriate current and voltage. Ensure compliance with the state and federal electrical regulations!
- The AC conductors must be between 10 AWG and 6 AWG / 6 mm^2 and 16mm^2 and with a temperature rating of 194°F / 90°C for all connections
- When selecting AC conductors, resistance should be minimized by selecting a larger size of conductors.
- Follow the safety instructions and specifications from the conduit manufacturers regarding installation.
- Terminate the conductors to the corresponding terminals in the connection area.
- Tightening torque of the terminal screws is 1.5 Nm / 1.11 ft-lbf.
- Check that the connection is performed correctly.

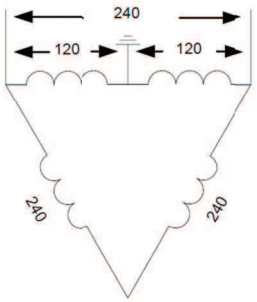
Single Phase with Neutral

240 : 120 Split Phase with Neutral



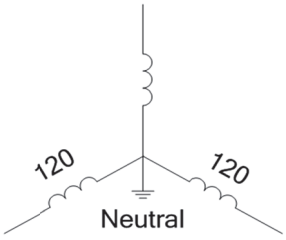
240 V_{AC} phase to phase
120 V_{AC} phase to neutral

240 Delta : 120 Stinger with Neutral



240 V_{AC} phase to phase
120 V_{AC} phase to neutral

208/120 WYE with Neutral



208 V_{AC} phase to phase
120 V_{AC} phase to neutral

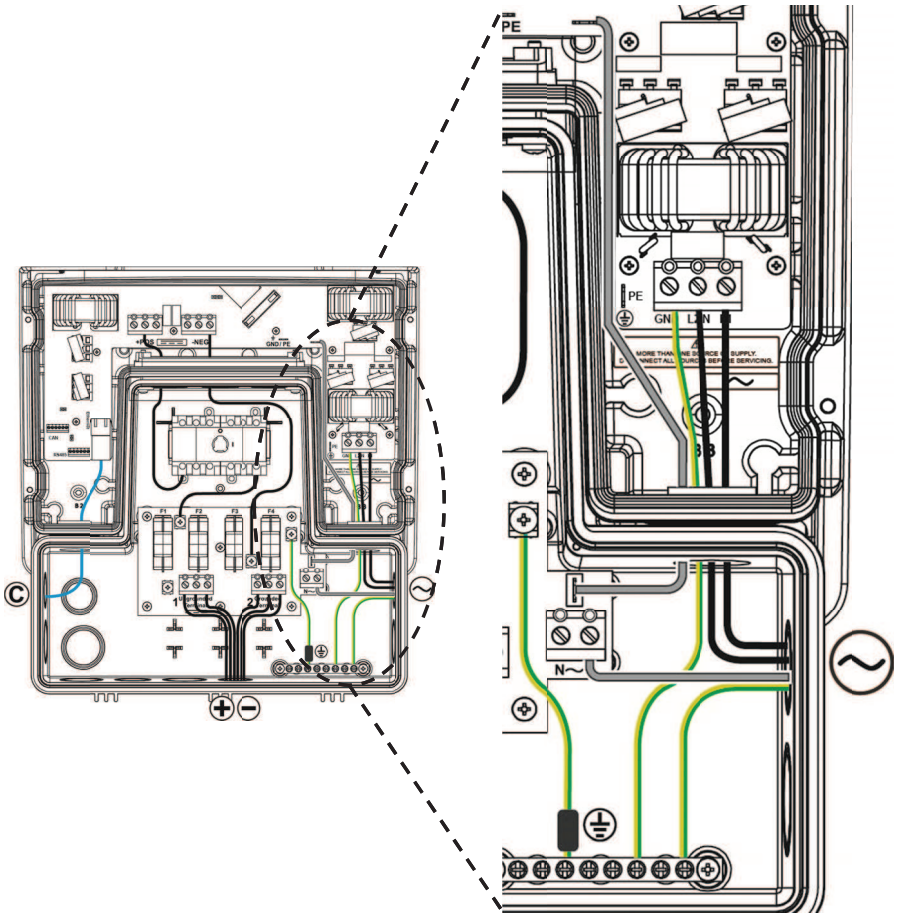
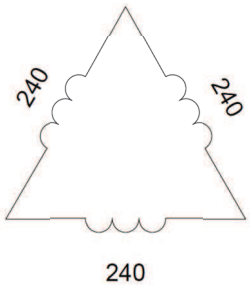


Figure 4.16: Connections for single phase with neutral

- Terminate the **line 1** conductor at the terminal labeled ***L1*** on the AC terminal block in the right side of the inverter lower compartment.
- Terminate the **line 2** conductor at the terminal labeled ***L2/N*** on the AC terminal block in the right side of the inverter lower compartment.
- Terminate the **neutral** conductor at the terminal block labeled ***N-N*** in right side of the Stringbox.
- Terminate the **equipment ground** conductor at the ***grounding bar*** in the lower right side of the Stringbox.
- Connect the **bonding strap** (white or grey colored) between the ***flat receptacle labeled N*** above the N-N terminal block in the Stringbox and the ***unmarked receptacle*** to the right of the DC ground terminal in the inverter lower compartment. This is to monitor the voltage between the phases and neutral.

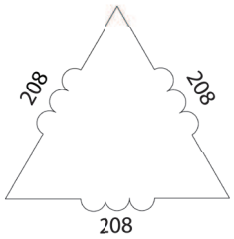
Single Phase with no Neutral

240 Delta



240 V_{AC} phase to phase only

208 Delta



208 V_{AC} phase to phase only

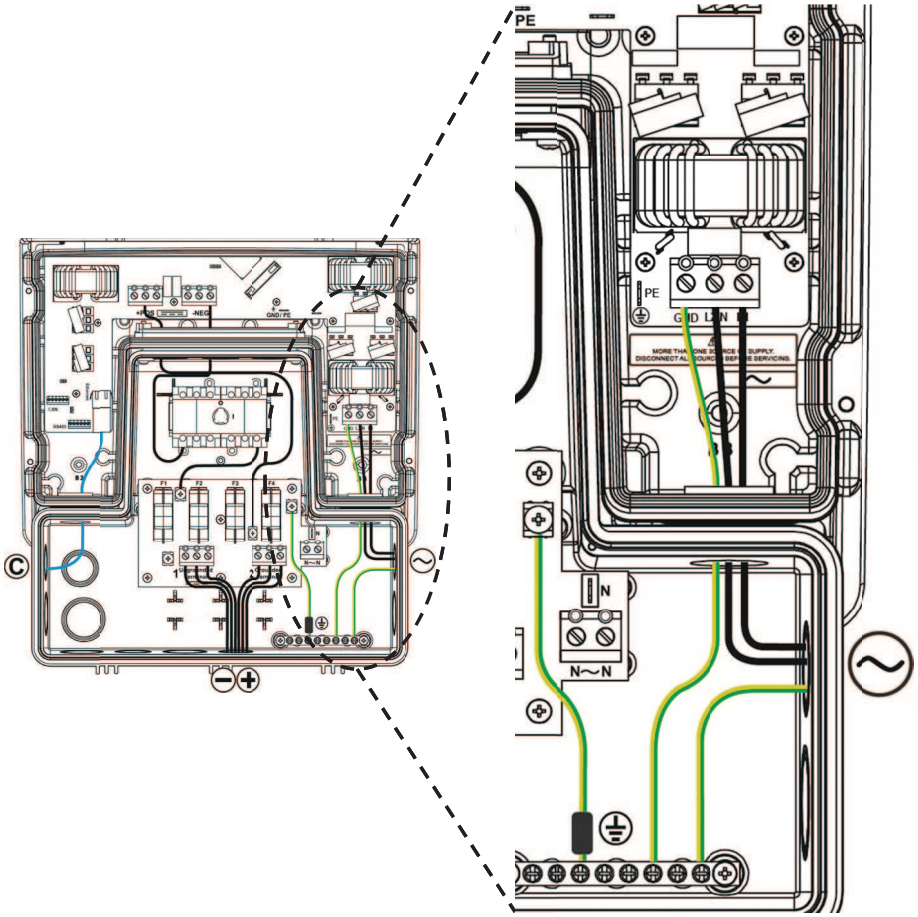


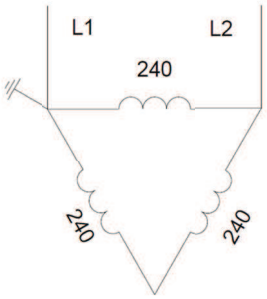
Figure 4.17: Connections for Delta grid with no neutral

- Terminate the **line 1** conductor at the terminal labeled ***L1*** on the AC terminal block in the right side of the inverter lower compartment.
- Terminate the **line 2** conductor at the terminal labeled ***L2/N*** on the AC terminal block in the right side of the inverter lower compartment.

- Terminate the **equipment grounding** conductor at the ***grounding bar*** in the Stringbox.

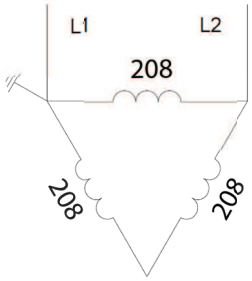
Delta: Corner Grounded

240 Delta : Corner grounded



240 V_{AC} phase to phase only

208 Delta : Corner grounded



208 VAC phase to phase only

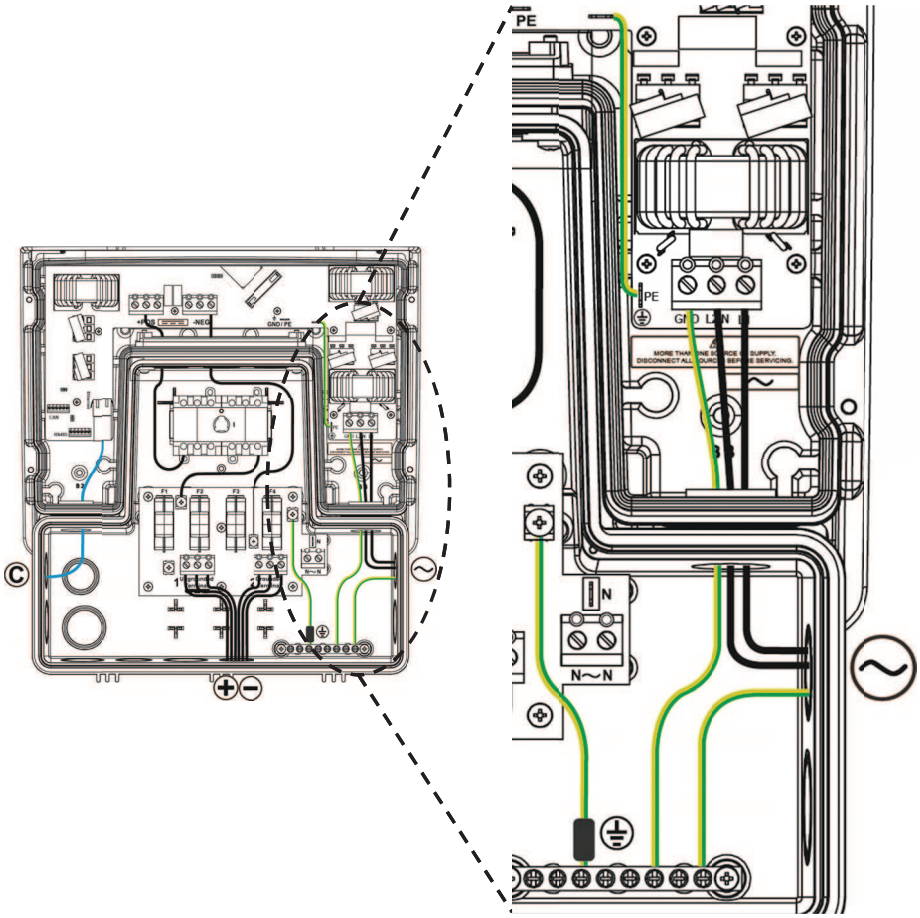
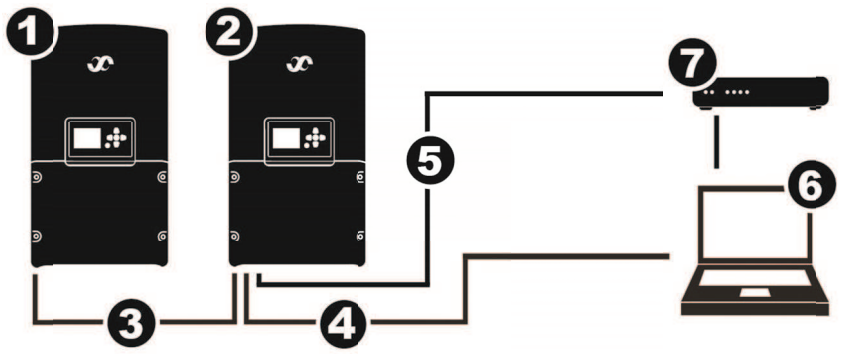


Figure 4.18: Connections for Delta corner grounded and Delta Wye

- Terminate the **line 1** conductor at the terminal labeled ***L1*** on the AC terminal block in the right side of the inverter lower compartment.
- Terminate the **grounded phase** conductor at the terminal labeled ***L2/N*** on the AC terminal block in the right side of the inverter lower compartment.
- Terminate the **equipment grounding** conductor at the ***grounding bar*** in the Stringbox.
- Connect the **grounding strap** (green and yellow colored) between the ***flat receptacle labeled PE*** to the left side of the AC terminal block and the ***unmarked receptacle*** to the right of the DC ground terminal in the inverter lower compartment. This is to monitor the voltage between ground and the grounded phase.

4.3.6. Network Connections

The inverter is equipped with three communication interfaces: Ethernet, CAN, and RS-485. **Ethernet** provides communication between the integrated web-server and a computer, either directly connected or via a router/switch. **CAN** allows communication between several inverters. **RS-485** allows communication with certain third party equipment.



1. Client inverter
2. Master inverter
3. CAN bus cable
4. Ethernet cable
5. RS-485 cable
6. Computer
7. Data logger

Figure 4.19:Connection without network

4.3.6.1. Connection Procedures

If several inverters are connected together, all inverters must be connected to the CAN bus prior to the *Start Up* procedure to benefit from single installation setup.

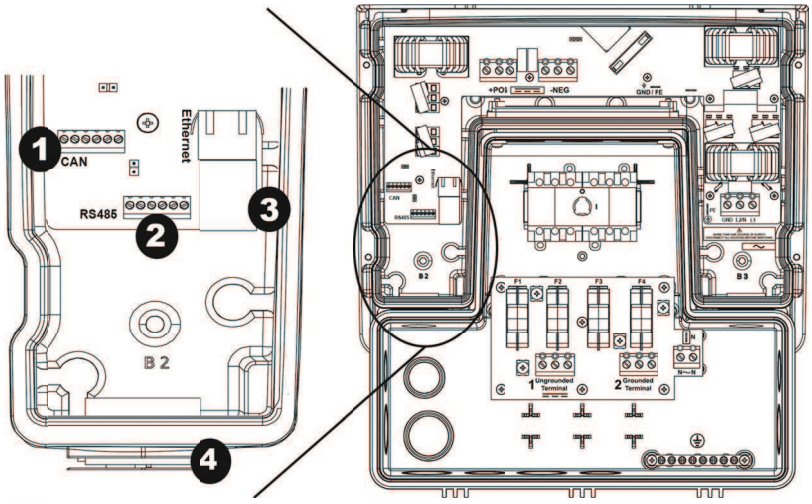


Figure 4.20: Network connection

1. CAN bus terminal
2. RS-485 terminal
3. Ethernet port
4. Cable gland

- **Ethernet:** Use CAT5 or better, with size 24 AWG / 0.21 mm^2 and a maximum total length of 100 m.
- **CAN:** Use a cable size of 26 AWG / 0.13 mm^2, with a maximum total length of 500 m.
- **RS-485:** Use a cable size of 26 AWG / 0.13 mm^2, with a maximum total length of 1200 m.
- Terminate the cables at the terminals in the connection area as follows:

  - **Ethernet:** Plug the Ethernet cable directly into the RJ45 port.
  - **CAN:** The conductors must be terminated to the same labeled terminals at both ends: i.e. ***H*** connected to ***H***, ***L*** to ***L*** etc. Applying 0.15 ft-lbf / 0.2 Nm of torque.
  - **RS-485:** The conductors must be terminated to the same labeled terminals at both ends: i.e. ***A*** connected to ***A***, ***B*** to ***B*** etc. applying 0.15 ft-lbf / 0.2 Nm of torque to tighten.

- Tighten the conduit fittings firmly.

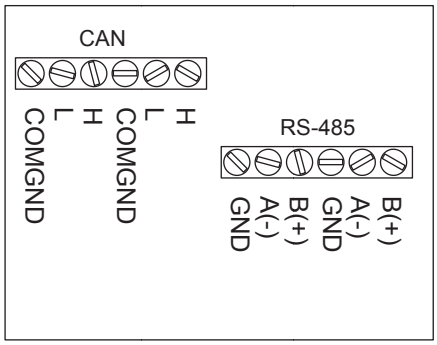


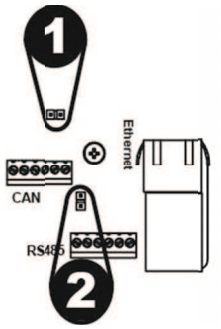
Figure 4.21: CAN and RS-485 connection pin-out

4.3.6.2. Jumper Position for Termination Resistance

When several inverters are connected, the jumper located behind the CAN / RS-485 terminals activates the termination resistance when the pins are terminated (short-circuited). This minimizes signal reflections in the cables and helps to avoid interference.

- **Single inverter:** The two pins can be terminated or disconnected.
- **Several inverters connected**: The *master-client* configuration requires terminated pins on the first inverter and on the last inverter in the linked series. The pins must be open on the inverters between the first and last inverter in the linked series.
- To disconnect the pins the jumper must be pulled up and placed only on one of the pins.
- Be careful not to bend the pins when removing or installing the jumper!

Table 4.4: Jumper position for the termination resistance

Connection Area	Jumper Position	Pins
		The pins are terminated.
		The pins are disconnected.

1. *CAN termination resistance*
2. *RS-485 termination resistance*

4.3.7. Checks before Start Up

☑ **Mounting:**
- Check that the bracket and the inverter are correctly mounted and secured.

☑ **PV wiring:**
- Check that the PV cables are rated for the PV current and for the expected environmental conditions.
- Check that the wiring is performed according to local and federal electrical regulations.

☑ **Connection:**
- Check that the PV conductors are correctly torqued to the DC terminals.
- Check that all connectors and cable glands are correctly tightened and sealed.

☑ **DC side:**
- Verify that the PV open-circuit voltage, V_{OC}, **does not exceed** 600 V_{DC}
- Check that the DC polarity is correct.

☑ **AC side:**
- Verify that the AC conductors on are correctly connected to the AC terminals.

☑ **Grounded conductors:**
- Check that the equipment grounding conductors are properly sized, and **not** fused or switched.

☑ **Jumpers:**
- Check that the jumpers for the grounding setup and for the termination resistance are correctly positioned.

☑ **Disconnects:**
- Verify that all current-carrying conductors on both the DC and AC side can be disconnected, and that the breakers and DC disconnects are located correctly and are easily accessible.

☑ **Overcurrent protection:**
- Verify that the overcurrent protection on both the DC and the AC side are sized correctly, and capable of being changed without touching live contacts.

☑ **Inverter cover:**
- Ensure that no cables interfere with the sealing of the inverter lower cover, and fasten the cover firmly to the housing. Recommended tightening torque is 1.0 Nm / 0.74 ft-lbf.

CAUTION

Verify that the lower cover is correctly tightened, so that no moisture enters the housing and damages the electronic components.

5. START UP

This chapter provides instructions to ensure a safe start- up of the *THEIA HE-t UL* inverters. A minimum voltage of **184V$_{AC}$**, and **230V$_{DC}$**, and a power greater than **7W$_{DC}$** is required from the PV system before the *THEIA HE-t UL*-t inverters start-up and begin feeding power to the grid. Do not attempt to start up or commission the inverter if one of the voltage sources is not available

AC Side

- Turn ON the AC circuit breaker(s).

DC Side

- Turn ON the DC switch(es).

5.1. Initial Start

When the inverter is started for the first time, an installation menu is automatically displayed to enable the configuration of certain values and operational settings.

5.1.1. Customizing the Inverter Settings

Single Inverter

- When both the DC and the AC disconnects are turned **ON** and the inverter is supplied with enough power, the installation menu is displayed on the LCD screen.

Multiple Inverters Connected

1. CAN

- Connecting all inverters via the CAN bus enables the configuration of all inverters in a plant via one inverter. The *Start Up* can then be carried out on any inverter, and if configured as the *master* inverter the configuration settings of *time*, *date*, *language* and *grid settings* will be transferred to all the other *client* inverters on the network.
- Each *client* inverter is automatically assigned an ID number from the *master* during *Start Up*.

NOTICE

If multiple inverters are connected together, all inverters must be connected to the CAN bus, and receiving sufficient AC and DC power, before *Start Up* to benefit from single installation setup.

2. RS-485

- Connecting the inverters via the RS-485 bus enables communication with certain 3rd party equipment. In an RS-485 network, the 3rd party equipment will act as a *master*, while all inverters will become *clients*.
- Each inverter must be assigned an ID number, a bit rate number and a parity number manually:
  - The ID number must be between 1 and 247.
  - Both the *master* inverter and the *client* inverters require a bitrate number and a parity number.
  - Determine the setup in the 3rd party equipment (e.g. an external data logger) and program these numbers in the inverter by accessing the network menu on the inverter display. Refer to section *6.2.3.2 Network Setup* for further details.
    Default bitrate: *19200*
    Default parity: *even*
- The RS-485 communication is compliant with **Sunspec Modbus specifications**.

5.1.2. User Interface

The *User Interface* on the front of the inverter contains a LCD screen, three LEDs and six function keys.

5.1.2.1. LCD Screen

To navigate in the LCD screen the six function keys must be used. By selecting one of the seven items in the *Main Menu,* a further navigation through different submenus is possible. There are four different menu levels.

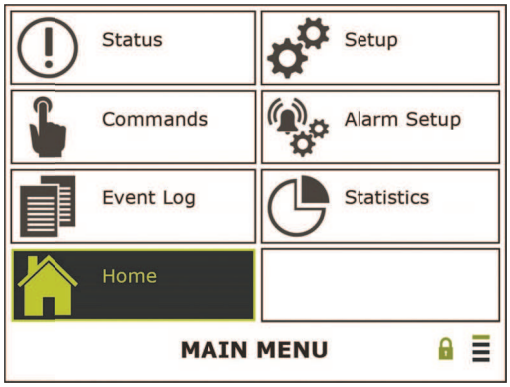


Figure 5.1: LCD screen interface

Home*, *Status*, *Event Log, Statistics:
The information and values are read-only.

Setup*, *Commands, Alarm Setup:
The information and values can be modified.

Padlock: Opens up when correct password is entered.

Lines: Number of highlighted lines indicates the current menu/submenu level, with the top line being the first level (*Main Menu*).

- To activate the display when the screen saver is active (blank), press any key.

5.1.2.2. LEDs

There are three LEDs next to the display screen. The upper one is red, the middle is yellow and the lower one is green.

Table 5.1: LEDs.

Symbol	LED	Function	Action
	Red	Malfunction! Inverter in shutdown mode	Look for alarms in *Active Alarms*
	Green & **Yellow**	Caution! Inverter still operates, but at a limited level	Look for warnings in *Active Alarms*
	Green	Operates; inverter feeds power to the grid	No action
NONE	**Yellow**	Inverter is OFF (Power < $7W_{DC}$)	No action

5.1.2.3. Function Keys

The function keys have the following uses:

Table 5.2: Function keys

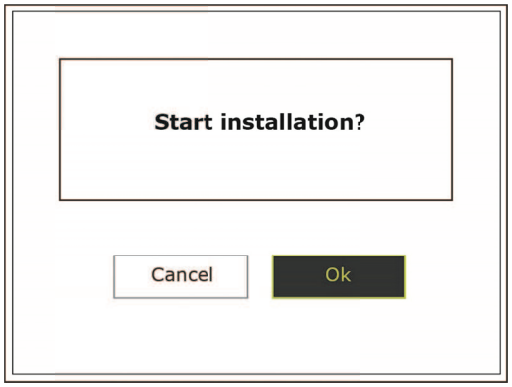
Symbol	Function	Symbol	Function
	***Up*:** Scroll up / increase value		***Right:*** Navigate one page or value right
	Down: Scroll down / decrease value		***Enter:*** Select option / go to next level
	Left: Navigate one page or value left		***Cancel:*** Stop operation / back to previous menu item

- The selected item is always highlighted in yellow.
- A registered touch of a button causes a "*click*" sound to be heard.

5.1.3. Start installation

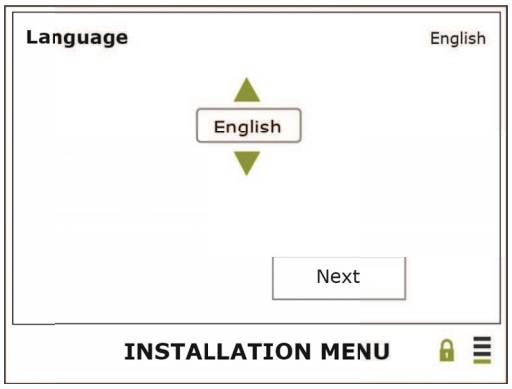
At first power-up, and with sufficient AC power, the display shows the *Start Installation* screen.

1. Start



Left – Cancel
Right – Ok
Enter – Confirm

2. Language Selection

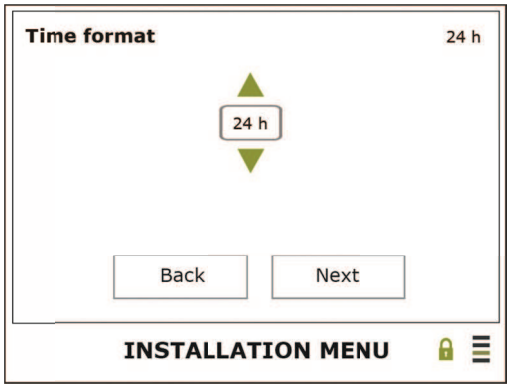


Default – English

Enter – Call up the list of languages
Up or ***Down*** – Navigate through the list to find the preferred language; *English; Spanish; etc...*
Enter – Confirm

Right – Next
Enter – Confirm

3. Time Format

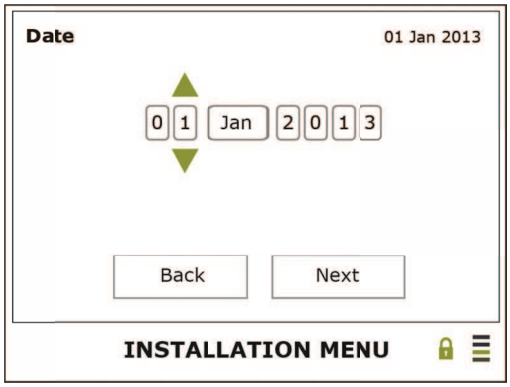


Default – 12 h

Enter – Call up the time format list
Up or ***Down*** – Select the time format; *12h, or 24h*
Enter – Confirm

Left – Back
Right – Next
Enter – Confirm

4. Date

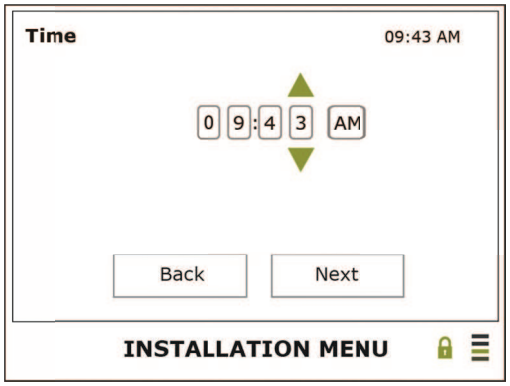


DD.MM.YYYY

Enter – Call up the date
Up – Increase present digit
Down – Decrease present digit
Left – Select previous digit
Right – Select next digit
Enter – Confirm

Left – Back
Right – Next
Enter – Confirm

5. Time



HH.MM

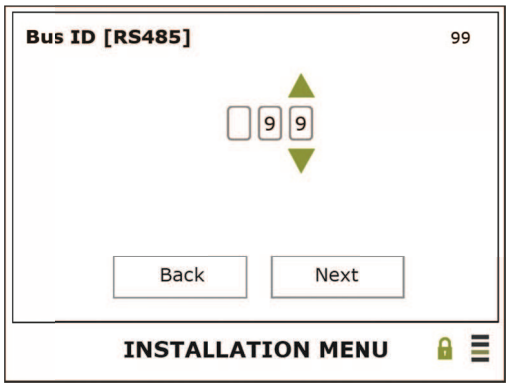
Enter – Call up the date
Up – Increase present digit
Down – Decrease present digit
Left – Select previous digit
Right – Select next digit
Enter – Confirm

Left – Back
Right – Next
Enter – Confirm

NOTICE

The time setting must match the time on the actual installation site; otherwise data may be overwritten!

6. Set Bus ID

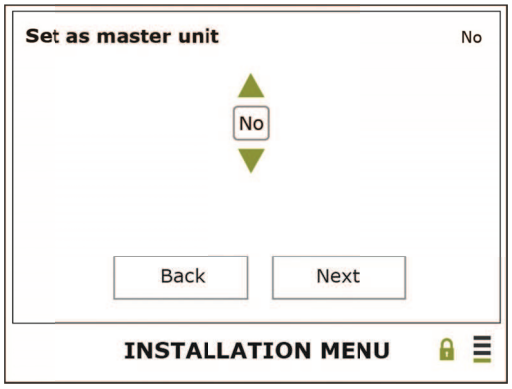


Enter – Call up the digits
Up – Increase present digit
Down – Decrease present digit
Enter – Confirm

Left – Back
Right – Next
Enter – Confirm

If RS485 communication is used, set a unique bus ID for the inverter. For any client inverters, this will be required to be set manually under **Setup › Network Setup › Bus ID (RS485)**. If RS485 communication is not used, this step can be missed.

7. Set as Master Unit



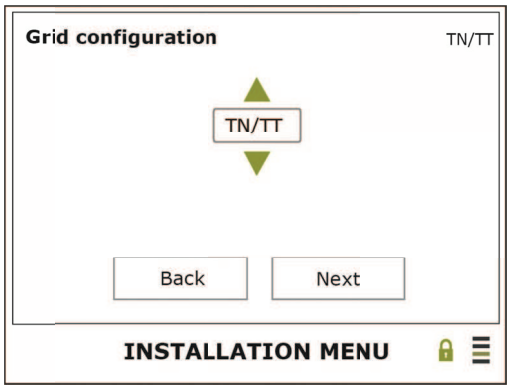
Default – No

Enter – Call up the options
Up – Yes
Down – No
Enter – Confirm

Left – Back
Right – Next
Enter – Confirm

If the inverter is set to *master*, data must be collected from the *client* inverters. The following screen will be displayed:

8. Grid Configuration (Earthing System)

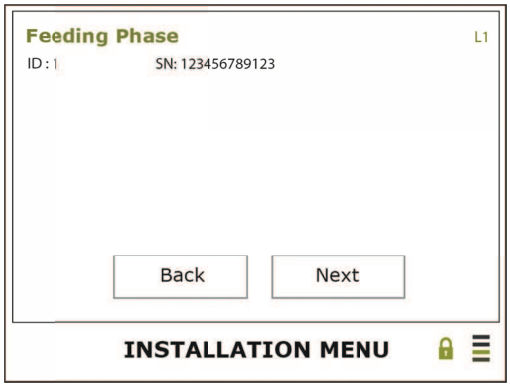


Enter – Call up the list of grid configurations
Up or ***Down*** – Select the grid configuration of the actual installation site:
TN/TT, *IT*, *Undefined*

Enter – Confirm

Left – Back
Right – Next
Enter – Confirm

9. Feeding Phase



Enter – Call up the list of phases

Up or ***Down*** – Select the preferred phase:
- If configured for **TN/TT**: *Not set*, *L1*, *L2*, *L3*
- If configured for **IT**: *Not set*, *L1-L2*, *L1-L3*, *L2-L3*

Enter – Confirm

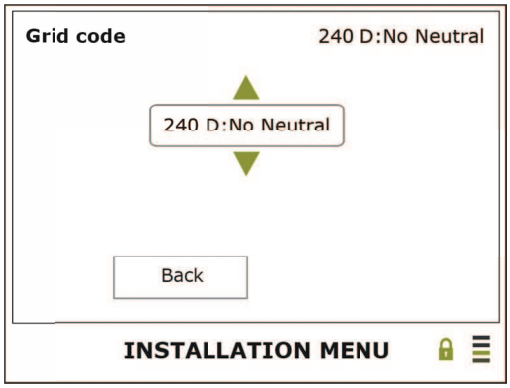
Left – Back
Right – Next
Enter – Confirm

If the inverter is set to *master*, and there is more than one inverter in the plant, the following screen is displayed:

Feeding Phase Information
Each Inverter in the plant must be configured through master or each inverter individually.
Do you want to configure through the master?
Cancel
Ok
INSTALLATION MENU

If the inverter is configured as *master*: step through and set the feeding phase (*L1, L2, L3, L1-L2, L1-L3*, or *L2-L3* as required) for all *client* inverters.

10. Grid Code



Enter – Call up the list of grid configurations
Up or ***Down*** – Select the grid setting of the actual installation site: Cont *240 D: No N; Cont 240D: 120spl; HI 208 D: 120Y; HI 208 D: C gr; etc.*
Enter – Confirm

Left – Back
Enter – Confirm

Due to the limitation in the number of characters that can be displayed on the screen the grid codes have been shortened from their full names. Please see below for a reference list of the abbreviations to relevant full names:

Table 5.3: Grid code abbreviation

Abbreviation	Full name
Cont 208D: No N.	Continental North America 208V Delta with No Neutral
Cont 208D: 120Y	Continental North America 208V phase to phase with 120V phase to Neutral
Cont 208D: C.gr	Continental North America 208V Delta with Corner Grounding
Cont 240D: No N.	Continental North America 240V Delta with No Neutral
Cont 240D: 120sp	Continental North America 240V phase to phase and 120V split phase and Neutral
Cont 240D: C.gr	Continental North America 240V Delta with Corner Grounding
HI 208D: No N.	Hawaii state 208V Delta with No Neutral
HI 208D: 120Y	Hawaii state 208V phase to phase with 120V phase to Neutral
HI 208D: C.gr	Hawaii state 208V Delta with Corner Grounding
HI 240D: No N.	Hawaii state 240V Delta with No Neutral
HI 240D: 120sp	Hawaii state 240V phase to phase and 120V split phase and Neutral
HI 240D: C.gr	Hawaii state 240V Delta with Corner Grounding

Grid Code Selection

If *Grid Code* setting fails and the grid code is not correctly set, the following window is displayed:

With inverters correctly connected in a *Master/Client* configuration a 'Warning' box is displayed if an error occurred during installation:

Warning Box

Possible errors:

1. No communication
2. Wrong grid settings
3. Sufficient DC power is unavailable on connected clients inverters

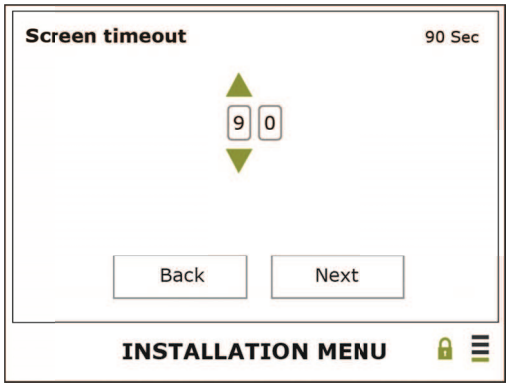
- Look at the displayed menu and the LEDs on the inverters: It is **not** carried out correctly if the installation menu is still displayed and/or the green LED is **not** lit and the yellow and red LEDs are lit.
- If the *Start Installation* screen is still shown, run through the installation process on the individual nverter.

CAUTION

- An installation timer ensures that the grid settings can be changed (using the *Owner* password) within **5 hours** of feeding power to the grid. Thereafter it is only accessible using the *Installer* password, which may only be obtained for installers and grid operators by contacting *Eltek*.
- The selected grid configuration must match that on the actual installation site; otherwise the inverter may not operate or be compliant to relevant state and federal electrical regulations due to incorrect limit values.

The following screen is displayed while inverter settings are being updated:

11. Screen Timeout



Enter – Call up the digits
Default – Screen backlight turns OFF after 60 sec

Left – Back
Right – Next
Enter – Confirm

NOTICE

The lowest value allowed to be set is **30 sec**, and the highest is **99 sec**. Setting the value to **0** disables the screen timeout and leaves the screen backlight **ON** at all times.

12. Customer Name

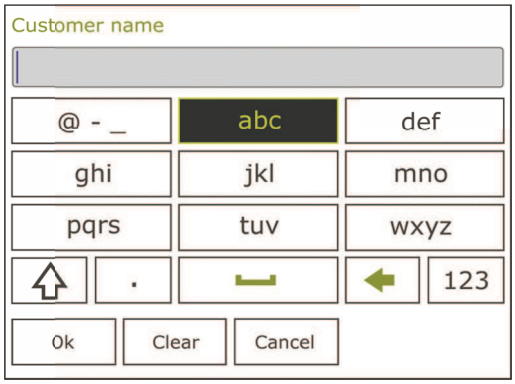
Enter – Call up the keyboard

The keyboard enables typing a text entry.

Left – Back
Right – Next
Enter – Confirm

In some of the submenus the settings must be typed using the function keys:

Letter keyboard



Number keyboard

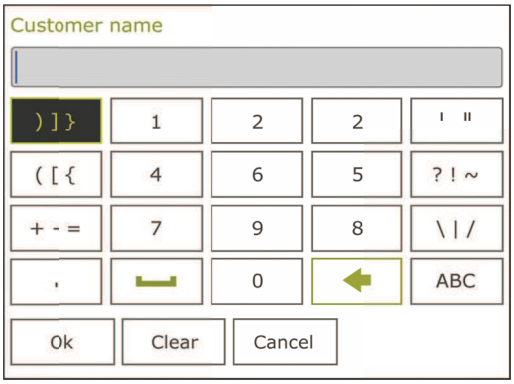


Table 5.4: Available symbols in the keyboard

Symbol	Description	Symbol	Description
	Upper- or lower-case letter	Ok	Confirm changes and exit the menu
	Point	Clear	Clear the typing field
	Space	Cancel	Go back without saving changes
	Cancel last letter	ABC	Go to the Letter keyboard
		123	Go to the Number keyboard

- *Enter* must be pressed until the wanted letter/number/symbol is shown.
- It is possible to navigate between the characters by using the *Up* arrow to set the marker into the text window, then using *Left* and *Right* to navigate between the characters.
- There is a maximum space for 19 characters in the text window.

13. Site

Enter – Call up the keyboard

The keyboard enables typing of a site name.

Left – Back
Right – Next
Enter – Confirm

14. Unit Name

Enter – Call up the keyboard

The unit name helps to distinguish and identify specific inverter in a larger plant.

Left – Back
Right – Next
Enter – Confirm

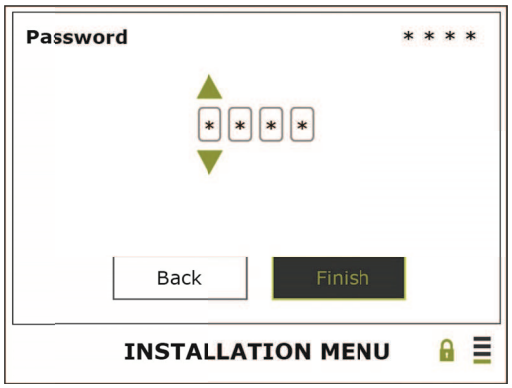
15. Message

Enter – Call up the keyboard

This message field is to help distinguish and identify specific inverters in a larger plant, or other information.

Left – Back
Right – Next
Enter – Confirm

16. Owner Password



Enter – Call up the digits
Default – 0003.
Change the password to 4 optional digits

NOTICE
This password is **not** transmitted to other inverters on the CAN bus on GUI firmware revisions below v1.32.

Left – Back
Right – Finish
Enter – Confirm

NOTICE

With several inverters connected it must be checked that the installation is been carried out correctly on all the *client* inverters.

- Look at the displayed menu and the LEDs: It is **not** carried out correctly if the installation menu is still displayed and/or the green LED is **not** lit and the yellow and red LEDs are lit.
- Check that the connection of the CAN cables are correct, that the AC and DC switches are ON, that the voltages are **›184 V_{AC}** and **230 V_{DC}** and there is a greater than **7 W_{DC}** of power.
- If the *Start Up* phase is correctly carried out the inverters are ready to use. They are fully automatic during normal operation, and no manual control is necessary for feeding power into the grid.

6. OPERATION

This chapter describes how to operate the menus in the LCD screen with the function keys or with a PC connected to the embedded webserver.

Please refer to *5.1.2. User Interface* for a description of the LCD Screen and the meanings of the colored LEDs

6.1. Access Levels and Passwords

There are three access levels to the different submenus:

Table 6.1: Password access levels

Password	Access
Guest	Read only access to all values.
Owner	Read and write access to all values and set levels except the installer related values. The default *Owner* password is **0003.** This password can be changed by navigating to: ***Setup› General Setup› Password.*** If the password is lost or forgotten, please contact *Eltek* to obtain a new password.
Installer	Read and write access to all levels and set values. The *Installer* password is based on the inverter serial number. If the password is lost or forgotten, please contact *Eltek* to obtain a new password. It will require the inverter serial number.

NOTICE

Any change of setting needs a password. Once the password has been entered, modifications must be done within **1 minute** before the access resets to *Guest* level.

6.2. LCD Screen Menus

To navigate in the LCD screen the six function keys must be used. By selecting one of the seven items in the *Main Menu,* a further navigation through different submenus is possible. There are four different menu levels.

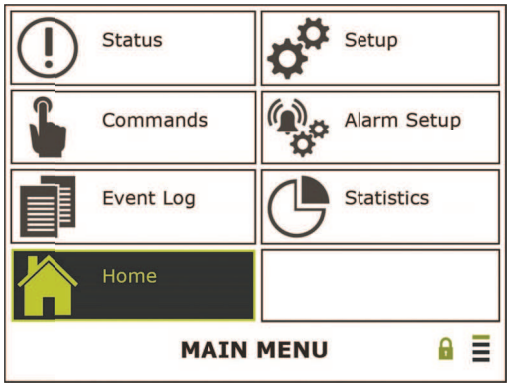


Figure 6.1: LCD screen interface

Home**, **Status**, **Event Log, Statistics:
The information and values are read-only.

Setup**, **Commands, Alarm Setup:
The information and values can be modified.

Padlock: Opens up when correct password is entered.

Lines: Number of highlighted lines indicates the current menu/submenu level, with the top line being the first level (*Main Menu*).

- To activate the display when the screen saver is active (blank), press any key.

6.2.1. Home

Home is the standard display, which is always shown if no buttons are touched within the screen timeout interval, which is set during installation (minimum 30 sec, maximum 99 sec, or OFF).
If the unit is set as *master*, the default menu contains status/mode information of the whole plant.

Single Inverter

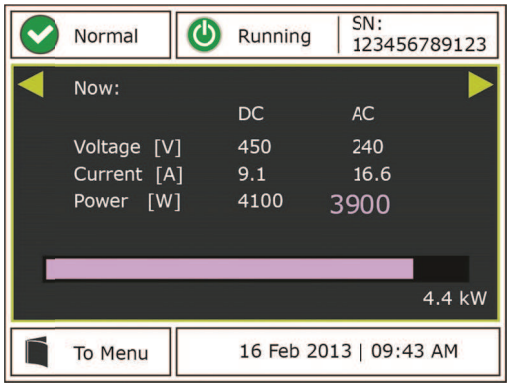


Figure 6.2: Standard display for a single inverter

Values of PV (DC) and feed-in (AC) current, voltage and power are shown numerically. The instantaneous output power is shown as a bar graph.

PV Plant

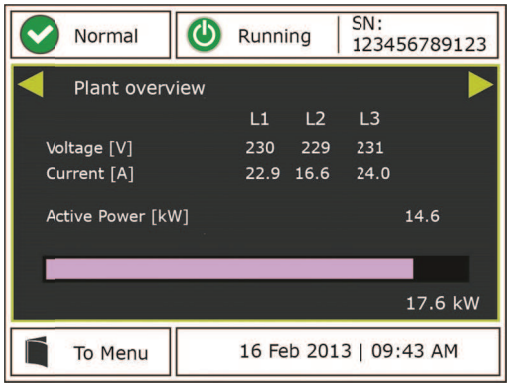


Figure 6.3: Standard display for a larger PV plant

Plant values of feed-in (AC) current and voltage for each phase, and active power for all phases are shown numerically. The current output power is shown as a bar graph.

Use the scroll keys to observe daily, monthly and yearly values:

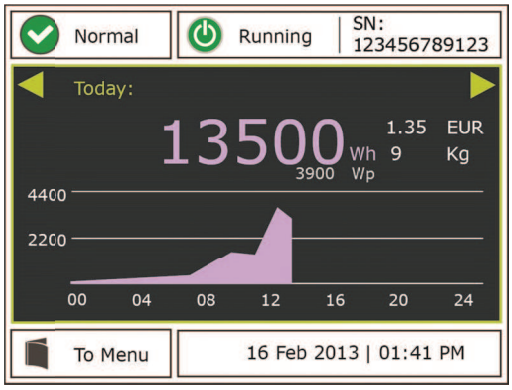


Figure 6.4: Energy harvest throughout the day

Up or ***Down*** – Navigate in the screen.
Left or ***Right*** – Observe the daily, monthly and total yearly values of :

- Energy harvest [Wh/kWh]
- Peak power [Wp]
- Earning [value of the respective country]
- Avoided CO_2 emission [kg].

6.2.1.1. Upper Display Area

The left section shows the status of the inverter. Refer to *Table 6.2* for the three different status options. It is also a shortcut to the *Active Alarms.*
The middle section shows the operation mode. Refer to *Table 6.3* for the eight different modes options.
The right section shows the serial number of the inverter, which is also to be found on the product label.

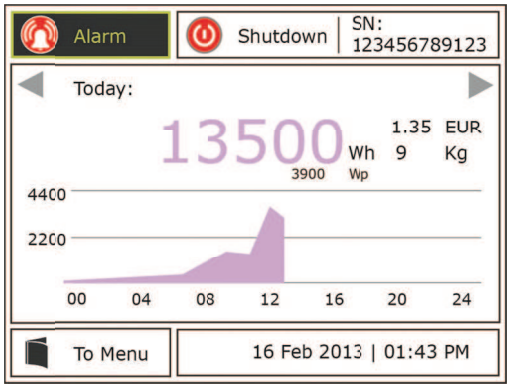


Figure 6.5: Upper display area of the home screen

Up or ***Down*** – Navigate in the screen.
Enter – Confirm

Table 6.2: Inverter status

Sign	Status	LEDS
	Normal: inverter operates with no warnings or alarms	Green
	Warning: inverter still operates, but there is a warning	Green&Yellow
	Alarm: inverter in shutdown, there is an alarm	Red
	Info: inverter still operates, but there is additional information available	Green&Yellow

Table 6.3: Inverter mode

Sign	Mode	LEDs
	Off: Input power is not sufficient to start the power control circuitry	Yellow
	Sleeping: automatic shutdown. Input power is not sufficient to start up	Yellow
	Start-Up: initialization of input values and grid conditions	Green & Yellow
	Running: grid feeding	Green
	De-rating: output power is reduced to protect the inverter against overheating	Green & Yellow
	Shutting Down: inverter in shutdown mode	Yellow
	Shutdown: inverter/system failure or unstable operational conditions	Red
	Service Mode: inverter can be manually overridden	Yellow

6.2.1.2. Lower Display Area

The lower section contains a shortcut to the *Main Menu* and shows the current date and time.

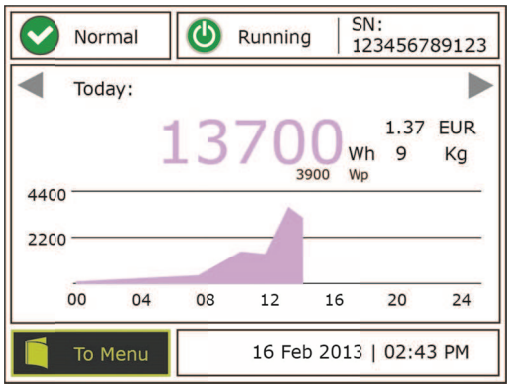


Figure 6.6: Lower display area of home screen

Up or ***Down*** – Navigate in the screen.
Enter – Confirm

6.2.2. Status

Status displays the operating mode and status of the inverter and the PV plant. All the values are read-only.

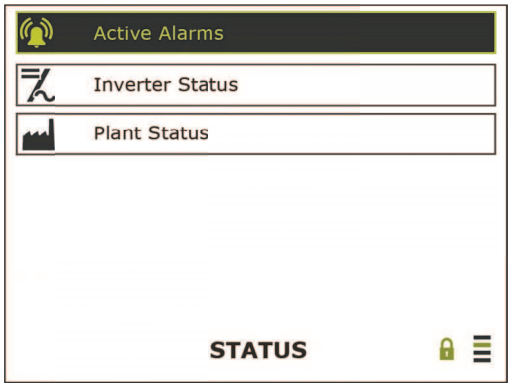


Figure 6.7: Submenus of Status

Up or ***Down*** – Navigate through the submenus
Enter – Select a submenu/confirm

6.2.2.1. Active Alarms

Active Alarms displays detailed information about the current operating mode - and status signs appearing in the upper left corner of the *Home* screen. Refer also to *7.2. Table of Events*.

6.2.2.2. Inverter Status

Inverter Status displays the operating mode, status and operating parameters of the inverter.

Inverter Mode	The inverter has 8 different modes. Refer to ***Error! Reference source not found.***
Inverter Error	The inverter has 3 different status levels. Refer to ***Error! Reference source not found.***
Input Parameters	Current, voltage and power fed from the PV modules to the inverter
Output Parameters	Current, voltage, frequency and power fed from the inverter to the grid
Inverter Peak Power	Highest power achieved throughout the day
Energy produced today	Total energy harvest throughout the day
Temperature	Temperature inside the inverter
Isolation Resistance	Level for a safe insulation between DC - and AC side to prevent injury or equipment failure. The resistance should be minimum 600 kΩ
Operating Hours	Total inverter running time from *Start Up*
Apparent Power (VA)	The product of voltage and current from the inverter [VA]
Extended Status 1[1]	0xZZZZ (hexadecimal code for diagnostics/service)
Extended Status 2[1]	0xZZZZ (hexadecimal code for diagnostics/service)

1. Extended Status codes are available from GUI revision 1.41 onwards.

6.2.2.3. Plant Status

Plant Status displays the operating mode, status and operating parameters of the PV plant, if there are other inverters connected, and the inverter has been set as the *master* unit.

Plant Mode	The plant has 8 different modes. Refer to ***Error! Reference source not found.***
Plant Status (Error)	The plant has 3 different status levels. Refer to ***Error! Reference source not found.***
Number of inverters	Total number of inverters in the plant
Number of active inverters	Number of active inverters in the plant
Number of inverter alarms	Event alarms in the plant
Number of inverter warnings	Event warnings in the plant
Input Current	Total current from the PV modules to the inverters
Input Power	Total power from the PV modules to the inverters
Output Power	Total feed-in power to the grid from all active inverters
Energy produced today	Total energy production throughout the day for the plant

Phase Values

Phase Values displays the inverter's various feed-in parameters for the different grid phases.

Output current (L1)	Value of current fed into phase 1
Output voltage (L1)	Value of voltage fed into phase 1
Output power (L1)	Value of power fed into phase 1

Output current (L2)	Value of current fed into phase 2
Output voltage (L2)	Value of voltage fed into phase 2
Output power (L2)	Value of power fed into phase 2
Output current (L3)	Value of current fed into phase 3
Output voltage (L3)	Value of voltage fed into phase 3
Output power (L3)	Value of power fed into phase 3

6.2.3. Setup

Setup displays settings and data from the inverter, the grid and the PV plant.

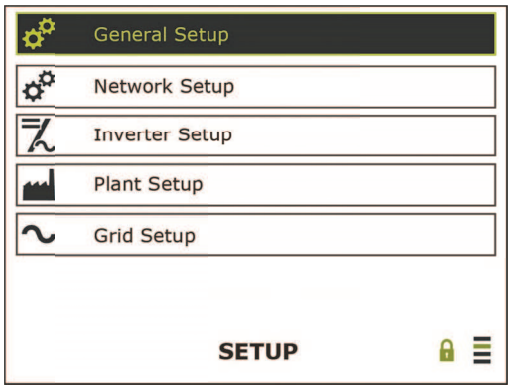


Figure 6.8: Submenus of Setup

Up or ***Down*** – Navigate through the submenus
Enter – Select a submenu/confirm

6.2.3.1. General Setup

General Setup displays some of the general parameters of the inverter, which can all be changed using the *Owner* password.

Language	The preferred language must be set during installation: English [default], German, Spanish, French, Italian, etc.
Time format	The time format must be set during installation: 24 h [default], 12 h.
Date	Current date must be set during installation
Time	Current time must be set during installation
Time zone	Used to define the time zone used for FTP data upload
Password	*Owner* password must have 4 digits. Default is 0003
CO_2 Rate	Avoided CO_2 emissions, based on 0.7 kg/kWh
Earnings Rate	Feed-in tariff in the respective country
Earnings Currency	Valid currency in the respective country
Screen Timeout	ON time for the display backlight
Power Saving during night time	Power saving can either be ON or OFF during nighttime. Enabling this option turns the GUI off 15 minutes after the inverter enters OFF mode, ie. night time, to save power. Only applicable for *client* inverters

6.2.3.2. Network Setup

Network Setup displays the settings for the connected network, which can all be changed with the *Owner* password. Refer to *6.3 Connection between Inverter and PC*.

NOTICE

All IP addresses related to the inverter and web must be configured within the range that is allowed by the local network.

Network IP-Address [Static/DHCP]	Unique network address for the inverter Indicates whether the IP address is static or dynamically assigned
Network Subnet Mask	Determines what subnet the IP-address belongs to
Network Gateway	Network point acting as entrance to another network
DNS server IP	The DNS IP address
Bus ID (RS-485)	The inverter's identification number on the RS-485 bus
RS485 bitrate	Measurement of data transmitted in a given amount of time [bps]
RS485 parity	Error detecting code: A bit that ensures an odd or even number of bits in a set of bits with value one. Selection: None, Odd, or Even
Bus ID (CAN)	The inverter's identification number on the CAN bus
Set as Master unit	Several inverters connected together in a power control and monitoring system, must have one *master* inverter and the rest must be *client* inverters.

6.2.3.3. Inverter Setup

Inverter Setup displays the various data for the specific inverter set during the manufacturer process, and is read-only.

Model	Inverter model
Serial Number	Unique identifier for each inverter. Also to be found on the product label
***Inverter* Part No.**	Identifier for each inverter hardware configuration within *Eltek*
***Inverter* Revision**	Unique version name for keeping track of the development of different inverter revision within *Eltek*
GUI Software Part No.	The GUI[1] software part number.
GUI Software Revision	Revision number for the GUI software
GUI Hardware Part No.	Identifier for the GUI-card hardware
GUI Hardware Revision	Revision number for the GUI hardware
SW1 Part No.	The DSP1[2] software part number.
SW1 Revision	Revision number for the DSP1 software
SW1 CS	The DSP1 software checksum
SW1 BL Part No.	The DSP1 bootloader software part number
SW1 BL Revision	Bootloader revision number for the DSP1 software
SW1 BL CS	The DSP1 bootloader software checksum
Control Board Part No.	DSP-card hardware part number
Control Board Revision	Version name for the DSP control card hardware
Main Board Part No.	Identifier for the PCB[3] hardware.
Main Board Hardware Revision	Unique revision number for keeping track of the development of different main board revisions
SW2 Part No.	The DSP2 software part number

SW2 Revision	Revision number for the DSP2 software
SW2 CS	The DSP2 software checksum
SW2 BL Part No.	The DSP2 bootloader software part number
SW2 BL Revision	Bootloader revision number for the DSP2 software
SW2 BL CS	The DSP2 bootloader software checksum

1. GUI = Graphical User Interface, which allows interaction with the inverter through the display.
2. DSP = Digital Signal Processing, which is a microprocessor controlling the power conversion in the inverter.
3. PCB = Printed Circuit Board, which hosts all the components and subsystems of the inverter.

6.2.3.4. Plant Setup

Plant Setup displays useful information about the PV plant, which can be changed using the *Owner* password.

Company/Customer Name	The customer / owner name
Site	The site name
Installation Date	May be used for setting the install date
Service Date	May be used for setting the most recent service date
Responsible	Field for keeping a note of the company/person responsible for service
Unit Name	This text string is displayed in the *master* unit's list of connected inverters
Message	An extra message field for additional notes
Plant Apparent Power	The product of voltage and current from the entire PV plant [kVA]

6.2.3.5. Grid Setup

The *Grid Setup* displays the grid settings based on the selected country. The settings can be changed **within 5 hours** after the installation using the *Owner* password. Thereafter it is only accessible by using the *Installer* password, which will only be available to the installer by contacting *Eltek*.

Field Adjustable Trip Limits

The system installer may change the grid settings according to electrical regulations. The *Installer* password is needed to change these settings.

1. Voltage

208 VAC Delta: No Neutral, 120 WYE, Corner Grounded

Table 6.4: Adjustable voltage trip limits for 208 V_{AC}

Trip Limits	Trip Voltage		Trip Time	
	Min	Max	Min	Max
Low limit	180.0 V_{AC}	208.0 V_{AC}	50 ms	1.95 s
Low and fast limit	104.0 V_{AC}	208.0 V_{AC}	50 ms	120 ms
High limit	208.0 V_{AC}	249.6 V_{AC}	50 ms	950 ms
High and fast limit	208.0 V_{AC}	249.6 V_{AC}	50 ms	120 ms

240 V_{AC} Delta: No Neutral, 120 Split-phase, 120 Stinger, Corner Grounded

Table 6.5: Adjustable voltage trip limits for 240 V_{AC}

Trip Limits	Trip Voltage		Trip Time	
	Min	Max	Min	Max
Low limit	180.0 V_{AC}	240.0 V_{AC}	50 ms	1.95 s
Low and fast limit	120.0 V_{AC}	240.0 V_{AC}	50 ms	120 ms
High limit	240.0 V_{AC}	270.0 V_{AC}	50 ms	950 ms
High and fast limit	240.0 V_{AC}	288.0 V_{AC}	50 ms	120 ms

2. Frequency

Table 6.6: Adjustable frequency trip limits

Trip Limits	Trip Frequency		Trip Time	
	Min	Max	Min	Max
Low limit	55.00 Hz	60.00 Hz	50 ms	80 ms
High limit	60.00 Hz	63.00 Hz	50 ms	80 ms

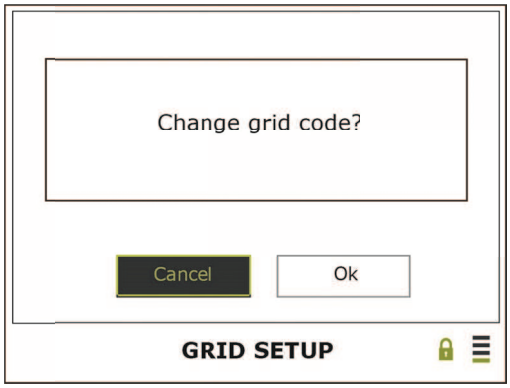
General Grid Setup

General Grid Setup displays grid parameters related to the selected grid.

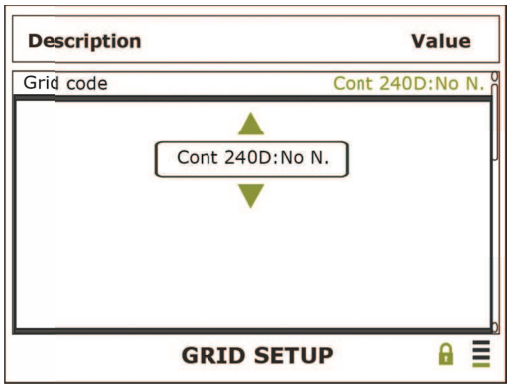
Grid code	Grid code of installation
Description	Name of the grid protection standard
Grid nom voltage	Nominal voltage of the grid on site
Grid nom frequency	Nominal frequency of the grid on site
Grid configuration	Grid configuration of the site: e.g. Delta Split-phase, Stinger etc
Feeding phase	The phase the inverter is connected to:
Voltage limit min	Lower disconnection limit of the grid voltage on site
Voltage limit max	Upper disconnection limit of the grid voltage on site
Voltage time limits min	Minimum disconnection time limit
Voltage time limits max	Maximum disconnection time limit
Frequency limits min	Lower disconnection limit of the grid frequency on site
Frequency limits max	Upper disconnection limit of the grid frequency on site
Frequency time limits min	Minimum disconnection time limit
Frequency time limits max	Maximum disconnection time limit

6.2.3.6. Changing the Grid Code

- From the *Main Menu:* ***Setup*** › ***General Grid Setup*** › ***Grid Code***.
- ***Enter*** – Confirm.
- After **5 hours** of feeding in power to the grid after installation the *Installer* password must be used to change the grid code settings. The *Installer* password is obtained for system installers and grid operators only by contacting *Eltek*.
- The question "*Change grid settings?*" appears in the display.



OK – Continue
Cancel – The operation is cancelled



Up or ***Down*** – Select the respective grid code
Enter – Confirm

After the grid settings are changed, the screen will return to the *Grid Setup* screen, showing the newly configured grid settings.

6.2.4. Commands

Commands give the ability to delete stored data in the inverter logger using the *Owner* password.

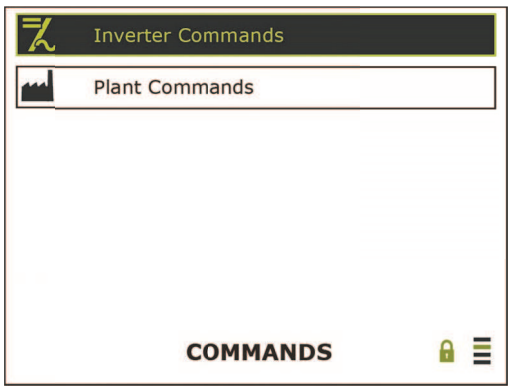


Figure 6.9: Submenus to Commands

Up or ***Down*** – Navigate through the list
Enter – Select a submenu/confirm

6.2.4.1. Inverter Commands

Inverter Commands gives the ability to delete events saved in the inverter data logger to provide storage space.

Delete Energy Log	Deletes the energy log items and summarized values of the inverter
Delete Data Log	Deletes the 15 minutes average power values of the inverter
Reset Web Admin Account	Resets the web administrator account back to default. *User* is set to ***admin*** and *Password* to ***admin***
Upload service diagnostics	Generates service FTP dump of logs data-, energy-, and events, and upload it to an FTP server for service purposes.

6.2.4.2. Plant Commands

Plant Commands gives the ability to delete events saved in the data logger of the *master* inverter to provide storage space.

Delete Energy Log	Deletes the energy log items and summarized values of the plant
Delete Data Log	Deletes the 15 minutes average power values of the plant
Reset Number of Inverters	Update if inverters are added or removed from the plant
Rebuild plant energy log	Rebuilds the plant energy log based on the energy logs of the inverters currently connected and running in the system. This process may take several minutes.

6.2.5. Alarm Setup

Alarm Setup enables configuration of an email account, so the inverter can send information about energy production, status and operation mode to one or more receivers. Changes require use of the *Owner* password.

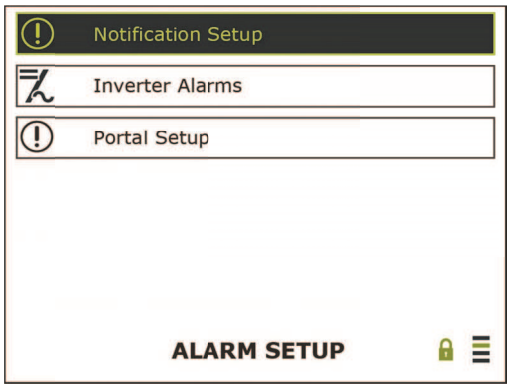


Figure 6.10: Submenus to Alarm Setup

Up or ***Down*** – Navigate through the list
Enter – Select a submenu/confirm

6.2.5.1. Notification Setup

In *Notification Setup* parameters needed for the inverter to send notifications about mode and status on e-mail must be typed in.

SMTP Server	The IP address of the SMTP server for enabling delivery of emails. Can only be an IP address (ie. numeric).
SMTP port	Sets the SMTP port number for SMTP server. Default is 25 (initially shown as 0)
User Name	User name for the mail server
Password	Digits, letters and symbols making up the user password for the mail server.
Sender email address	A valid email address, eg: xxxx@xxxxxx.xxx, required to be able to send notifications
Receiver email 1	Mail address for recipient 1
Receiver email 2	Mail address for recipient 2

E - Mail Set-up

To enable the inverter to send e-mail notifications an SMTP server is required, which transfers the mails to the receiver(s). Most companies have their own server, while normal households most likely have to use their internet service provider (ISP) mail server.

NOTICE

If an inverter is moved, or connected, to another network not operated by the same ISP, a new SMTP server must be assigned.

Procedure

Go to the inverter menu ***Alarm Setup*>*Notification Setup***. Complete the text fields (Refer to section *6.2.5.1. Notification Setup*).

- **User Name and password:** Usually provided by the ISP provider.
- **Sender email address:** This is the e-mail address appearing in the *From* field when receiving emails from the inverter. It must be configured as follows: *name@domain*
- **Receiver 1 and 2:** The recipients' e-mail addresses.
- **SMTP server:** The SMTP server address.

NOTICE

- All IP addresses related to the inverter and web must be configured within the range that is allowed by the local network
- For GUI revisions below v1.32, the server address must be configured with numbers.
- For GUI revisions v1.32 onwards: if using a domain name, the DNS IP address needs to be specified under ***Setup* > *Network Setup***.
- Be aware that the ISP provider can change the SMTP IP address without any notification. If the e-mail reports suddenly stops, do an *nslookup* to see if the IP address has been changed!

6.2.5.2. Inverter Alarms

In *Inverter Alarms* the settings for notification types and time intervals of the inverter emails to the receiver(s) must be defined.

Send production on email 1	Specified time for sending information about energy production to email 1
Send mode on email 1	Immediately sends notification to e-mail 1 if operation mode changes
Send alarm on email 1	Immediately sends notification to e-mail 1 if warning or alarm
Send production on email 2	Specified time for sending information about energy production to email 2
Send mode on email 2	Immediately sends notification to e-mail 2 if operation mode changes
Send alarm on email 2	Immediately sends notification to e-mail 2 if warning or alarm
Interval	Interval between the notifications: None, Hourly, or Daily
Notification time	Time for daily interval for e-mailing information about the energy production. Used if interval is set to Daily

6.2.5.3. Portal Setup

Portal Setup displays settings for uploading data to a web portal. Fifteen-minute averaged energy data is uploaded every hour to the portal. The upload is disabled if the user name is left blank. The portal setup is compatible with *Meteocontrol Setup*.

FTP Server IP	FTP server IP address.
FTP Port	Sets the FTP port number for FTP server. Default is 21
User Name	FTP server user name
Password	FTP server password

Note: Only an inverter configured as a *Master* will upload FTP data. For third-party FTP services, an additional cost may be applied

6.2.6. Event Log

Event Log displays information about the inverter's logged events. The events are listed with the most recent event first.

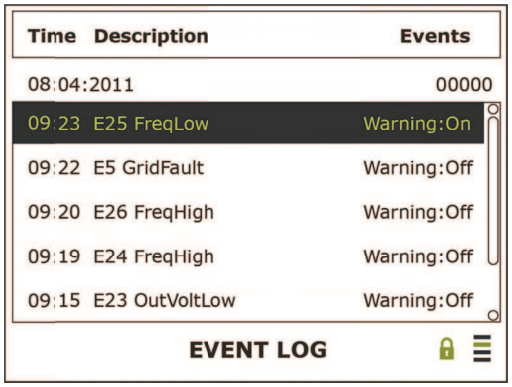


Figure 6.11: Events in the log

Up or ***Down*** – Read the different values
Left – Go back to the previous screen
Right – Go to next screen

Warning On means that a warning event has occurred.
Warning Off means that an event has cleared.

6.2.7. Statistics

Statistics displays values for the daily, monthly, yearly and total energy harvest, earnings, CO_2 savings and peak power. The information is read-only.

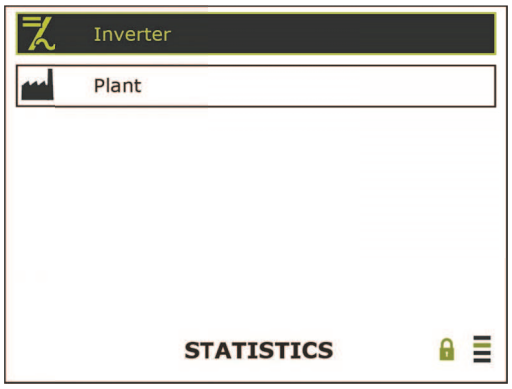


Figure 6.12: Submenus to Statistics

Up or ***Down*** – Read the different values
Enter – Select a submenu/confirm

6.2.7.1. Inverter

Inverter displays a summary of the most important statistics of the inverter from today, this month, this year and in total since *Start Up*.

Energy	Inverter's total energy production [kWh]
Earnings	Cash value of the feed-in energy in currency/kWh
CO_2 avoided	Avoided CO_2 emissions [kg/kWh] compared to fossil fuel
Peak Power	Inverter's largest instantaneous amount of power production [W]

6.2.7.2. Plant

Plant displays a summary of the most important statistics of the PV plant from today, this month, this year and in total since *Start Up*.

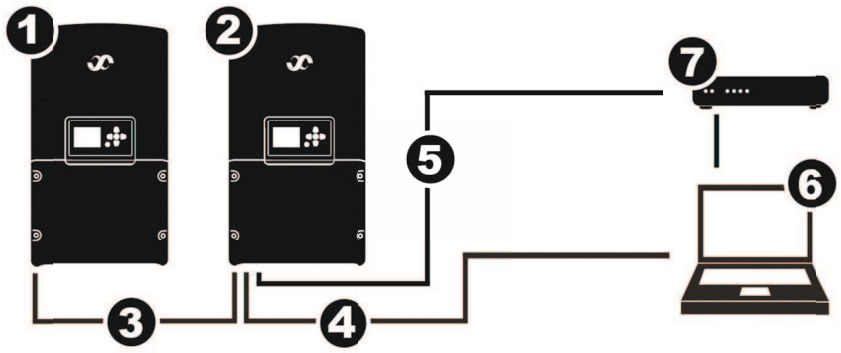
Energy	Plant's total energy production [kWh]
Earnings	Cash value of the feed-in energy in currency/kWh.
CO_2 avoided	Avoided CO_2 emissions [kg/kWh] compared to fossil fuel
Peak Power	Plant's largest instantaneous amount of power production [W]

6.3. Connection between Inverter and PC

Site performance can be monitored remotely by using a computer. The connection between the inverter and the computer can be configured directly or via a network.

6.3.1. Without a Network

To connect the inverter directly to a computer a standard Ethernet cable is required. In cases where the network card in the computer does not support *Autosense*, a crossover cable is needed.



1. Client inverter
2. Master inverter
3. CAN bus cable
4. Ethernet cable
5. RS-485 cable
6. Computer
7. Data logger

Figure 6.13: Connection without network

NOTICE

With several inverters connected together via CAN bus, the Ethernet cable should be attached to the *master* inverter only.

6.3.1.1. IP Address

The computer and the inverter IP address must be in the same range. If the inverter IP address is *192.168.10.X*, the computer IP address must be *192.168.10.Y*, where X and Y are different numbers between 1 and 254.

Inverter

The inverter default IP address is *192.168.10.20*. To change the IP address, navigate to: ***Setup*>*Network Setup*** and set the inverter IP address as required.
To start the web connection to the inverter, open a web browser and type the inverter IP address into the web browser address line.

Computer

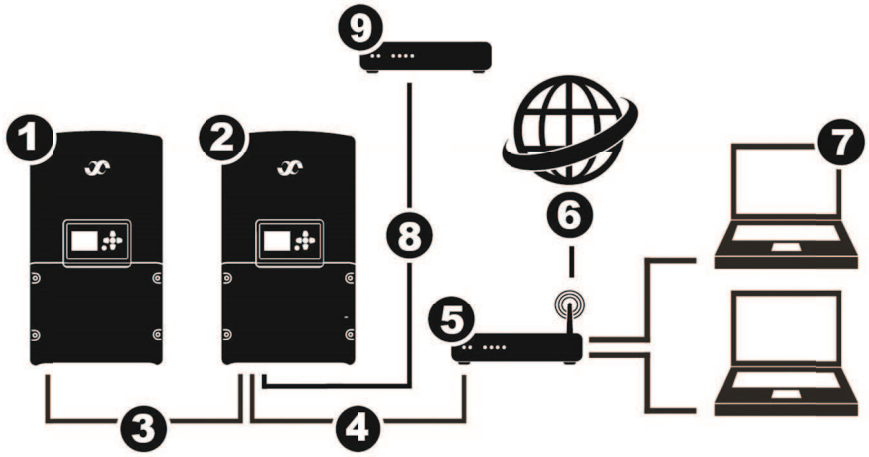
The example below shows the steps to be followed on a *Windows® 7** computer to manually change the computer's IP address. This procedure may vary on computers with other operating systems (OS):

1. Open the network menu by clicking ***Start***
2. Click ***Control Panel*** > ***Network and Sharing Center***
3. Click ***Local Area Connection*** > ***Properties***
4. Select ***Internet Protocol Version 4 (TCP/IPv4)*** > ***Properties***
5. Select ***Use the following IP address***.
   Enter the default parameters: IP address ***192.168.10.10***, subnet mask ***255.255.255.0***.
   Click ***OK*** and ***OK***

**Windows is either a registered trademark or a trademark of Microsoft Corporation in the United States and other countries.*

6.3.2. With a Network

If a LAN or WAN network is available, the inverter can be hard wired by a CAT 5 network cable to any RJ45 port, where the DHCP (*Dynamic Host Configuration Protocol*) server will automatically assign a dynamic IP address to the computer and the inverter.



1. Client inverter
2. Master inverter
3. CAN bus cable
4. Ethernet cable
5. Router/Switch
6. World Wide Web
7. Computer
8. RS-485 cable
9. Data logger

Figure 6.14: Connection with network and World Wide Web

To connect the inverter to a LAN or WAN network, use a standard CAT5 or better cable to any of the LAN RJ45 ports on the router.

6.3.2.1. With DHCP – Dynamic IP Address

Inverter

1. Go to ***Setup***>***Network Setup***.
2. Set the IP address to ***000.000.000.000***. With this setting the router assigns a dynamic (DHCP) IP address automatically to the inverter.
3. Press ***OK***. The GUI will restart to configure the new network settings.

6.3.2.2. Without DHCP – Static IP Address

Inverter

1. Go to ***Setup*>*Network Setup***.
2. Set the IP address to a desired, unique address for the inverter (Static). The inverter's IP address must be an unused IP address in the network and in the same range as the computer's IP address.
3. Press ***OK***. The GUI will restart to configure the new network settings.

6.3.3. Access from the Internet

In order to make the inverter(s) accessible from the internet, further parameters must be set within the network settings.

1. The inverter must be assigned a *static* IP address in the local network. Refer to the previous section.
2. *Port Forwarding* must be set up within the local network router. Port number *80* of the router is for Web traffic (HTTP), and must be forwarded to the inverter's static IP address. The external IP address of the router can be found at *http://www.whatismyip.com* or similar web services, or by asking the relevant Internet Service Provider (ISP).

NOTICE

If the external network is assigned a *dynamic* IP address from the ISP, this IP address is unlikely to remain constant over a long time period. It is possible for the inverter owner to set up an account with a company that provides dynamic DNS services for commercial and private users, which allows the user to have a hostname (such as: *yourname.serviceprovider.org*) that points to a computer with an IP address that regularly changes.
In order to have the dynamic DNS service operating correctly, the owner's router must be capable of reporting its IP address to the dynamic DNS service provider. This will most likely be present in the router settings section which asks for the details of the user account with the dynamic DNS service provider.
If the owner's router does not report its IP address to the dynamic DNS service and has a dynamic external IP address, then periodically a manual update of the dynamic DNS settings will be required.

3. When this is completed it should be possible to reach the *THEIA HE-t UL* webserver by typing the external IP address of the local network or the web address (if a dynamic DNS service is used) in the computer's web browser.

6.4. Internal Webserver

The inverter has an internal, onboard webserver providing detailed information about the operation, warning/alarms and energy production of the inverter/plant.

- The webpage is best viewed in *Firefox 6.0* or *Internet Explorer 8.0* and later versions.
- From the internal webserver some inverter settings can be changed via username and password.
- Type the inverter's IP address in the computer's web browser.
- Default administrator account is: **User:** *admin*, **Password:** *admin*.
  This can be changed by the user, and should be changed if the web server is connected to the internet.

6.4.1. Home

The *Home* screen is the standard display, which is always shown when opening the web server.

Figure 6.15: Standard display

- **System status** shows the status and operating mode of the inverter or the PV plant. Current power production and input values on DC and AC side are listed to the right.
- **PV plant:** More detailed information for specific inverters in a plant can be found in the drop-down menu under *Plant* to the right.
- **Production status** shows the energy yield for the current day, month and year.
- More detailed values from the production data can be viewed by hovering the mouse cursor over the graphs.

6.4.2. Statistics

Statistics gives a graphical overview over the energy production from the current week and the last 12 months.

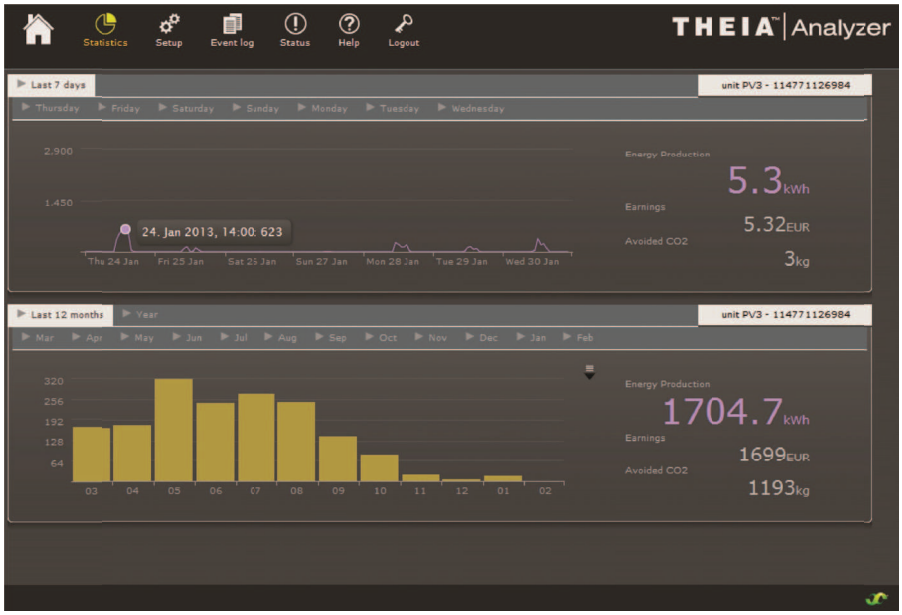


Figure 6.16: Statistics

- **PV plant:** More detailed information for specific inverters in a plant can be found in the drop-down menu under *Plant* to the right.
- More detailed values from the production data can be viewed by placing the mouse cursor over the graphs.

For GUI revision 1.32 and above:

- The energy log may be downloaded by clicking on the 'down' arrow (will be displayed if available).
- The energy data downloaded is determined by the unit selected in the dropdown box. This functionality may not work on certain mobile devices.

The data may be imported into a spreadsheet program, with the data format as follows:

<dp time="YYYY-MM-DD HH:MM:SS">
<en>WWWW</en>
<pw>wwww</pw>
<va>€€€€</va>
</dp>

dp: Datapoint – the date and time stamp of the entry
en: Energy for the interval in Wh (watt-hours)
pw: Peak power for the interval in watts

va: Earnings/savings for the interval with two decimal points, in the chosen currency, eg. '7778' is 77.78 Euros

6.4.3. Setup

Setup shows the different settings and information of every inverter in the PV plant.

Figure 6.17: Setup

- **Plant Information** shows important characteristics of every inverter in the PV plant. Model, serial number, revision and part no. information are all read-only.
- **General Settings** shows date and time, CO_2 - rating and rate and currency of the earning. All settings can be modified.
- **Alarm Setup** shows information related to notifications and alarms from the inverter/plant.

Notification Setup:	Type username and IP address/host name of the SMTP server, the IP address of the inverter and mail address of the receiver(s).
Alarm Setup:	Type time for sending email messages (0 – 23 h) and the interval of the messages (1440 min = 1 day).
Portal Setup:	The inverter may upload energy data to an FTP-server. Specify the server address (either IP address or DNS) in the FTP Server IP field, and optionally a username and password if needed. The data will be uploaded every hour. **Note:** only an inverter configured as a *master* will upload FTP data. For third-party FTP services, an additional cost may be applied.

- **Network** shows the parameters related to the sending and receiving of email messages. Type the IP address (configured with ***numbers*** like ***192.168.10.20***), network subnet mask and gateway. Refer to *6.3.1.1. IP Address*.
- **User Account** shows the current user accounts and provides the ability to setup and/or change user names and passwords. The different levels are:

1. **Guest:** Access level 1: Read only access to all values.
2. **Owner:** Access level 2: Read and write access to all values and set levels except the installer related values such as network settings and user accounts.
3. **Admin:** Access level 3: Read and write access to all levels and set values.

6.4.4. Event Log

Event Log shows information about events that the inverter has logged. The events are listed with the most recent event first.

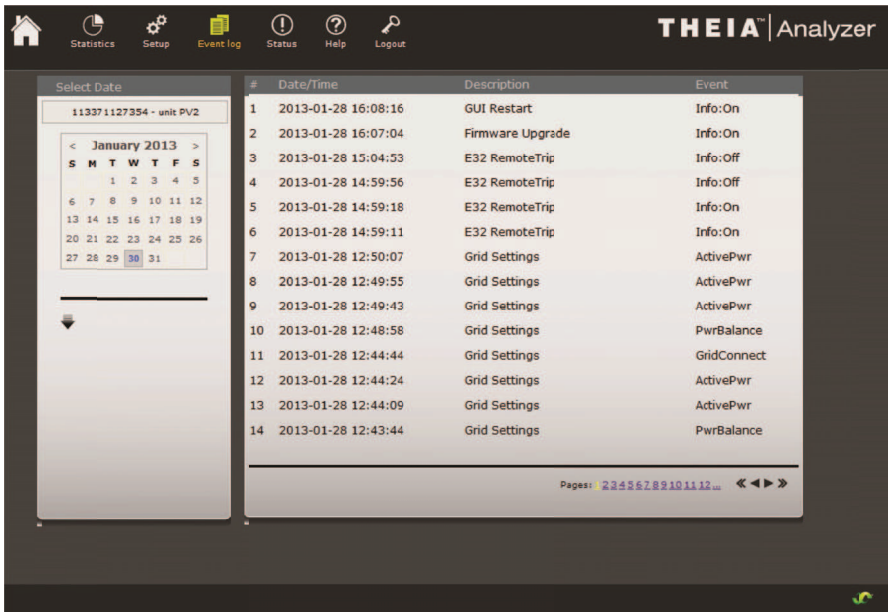

Statistics
Setup
Event log
Status
Help
Logout
THEIA | Analyzer
Select Date
113371127354 - unit PV2
January 2013
S M T W T F S
1 2 3 4 5
6 7 8 9 10 11 12
13 14 15 16 17 18 19
20 21 22 23 24 25 26
27 28 29 30 31
Date/Time Description Event
1 2013-01-28 16:08:16 GUI Restart Info:On
2 2013-01-28 16:07:04 Firmware Upgrade Info:On
3 2013-01-28 15:04:53 E32 RemoteTrip Info:Off
4 2013-01-28 14:59:56 E32 RemoteTrip Info:Off
5 2013-01-28 14:59:18 E32 RemoteTrip Info:On
6 2013-01-28 14:59:11 E32 RemoteTrip Info:On
7 2013-01-28 12:50:07 Grid Settings ActivePwr
8 2013-01-28 12:49:55 Grid Settings ActivePwr
9 2013-01-28 12:49:43 Grid Settings ActivePwr
10 2013-01-28 12:48:58 Grid Settings PwrBalance
11 2013-01-28 12:44:44 Grid Settings GridConnect
12 2013-01-28 12:44:24 Grid Settings ActivePwr
13 2013-01-28 12:44:09 Grid Settings ActivePwr
14 2013-01-28 12:43:44 Grid Settings PwrBalance
Pages: 1 2 3 4 5 6 7 8 9 10 11 12 ...

Figure 6.18: Event Log

- Recent events can be viewed by navigating directly to the different pages in the list on the bottom of the screen.
- Events from previous months and years can be viewed by specific dates using the calendar to the left.

For GUI revision 1.32 and above:

- The most recent events in the event log may be downloaded as a text file by clicking the “down”-arrow (will be displayed if available).
- The latest events from the clients may be displayed and downloaded. This is only available if the clients also have the same or newer GUI revision as the master unit.

6.4.5. Status

Status displays any warnings and alarms in the plant, and gives an overview of the plant's technical characteristics and energy yield.

Figure 6.19: Status

- **Alarms** tab identifies any specific warning or alarm in the plant, with any activated items highlighted.
  The *Extended Status* lines are used by *Eltek* service personnel to help diagnose possible faults.
- **Overview** provides input parameters from the PV panels to the inverter/plant, the output parameters from the inverter/plant to the grid, as well as earnings, avoided CO_2 emission and total energy production with peak values from the inverter/plant.
- **Plant** (available in a unit configured as a *master* when selecting '*Plant*' in the drop down list) provides a snapshot of the connected inverters, status and energy production information. To refresh the information, click the '*Plant*' tab.

7. TROUBLESHOOTING

This chapter contains useful information if the inverter malfunctions during operation. Start by checking the installation is carried out correctly, and the display information, and then check the information in *7.2. Table of Events* for possible solutions. If this does not help solve the problem, please contact the system installer.

7.1. Check List by Failure

If the inverter does not feed power to the grid, try to solve the problem by checking:

- ☑ That both the AC and DC disconnect circuit breaker(s)/disconnect(s) are **ON**.
- ☑ That the irradiation is sufficient to generate power (>7 W).
- ☑ That the operation mode of the LEDs is normal (Refer to *5.1.2.2. LEDs*).
- ☑ That there are no warnings or alarms in the display (Refer to *7.2. Table of Events*).
- ☑ That all connection points in the system are properly tightened.
- ☑ That the values of the PV voltage, current and power match those in the display.

If all these items are OK, and there is still no power fed to the grid, contact your distributor.

7.2. Table of Events

The inverter automatically identifies operational issues and displays the messages on the screen. Detailed information about warnings and alarms can be found in the *Event Log* menu. Refer to *6.4.4. Event Log*.

Messages that can appear in the display:

W = Warning: inverter continues to operate at highest possible capacity (Yellow LED)
A = Alarm (Red LED)

The Display Message code number (E01, E02, etc..) is the code shown in the event description as displayed in the Event Log of the webserver view:

Table 7.1: Description of messages appearing in the display during inverter failure

Display Message	Description	Action
Panel fault (**W/A – E01**)	PV module failure	- Contact the supplier*
Illegal grid setting (**W/A – E02**)	Grid settings check sum error.	- Verify if the AC circuit breaker is ON and operational - Measure that the grid voltage is >184Vac at the AC terminals - Check that the DC switch is ON and that the DC power is >7W - Check that the grid settings have been successfully set in *Setup>Grid Setup*
Uninitialized grid setting (**W – E03**)	No detection of the grid, or grid setting never stored	- Check that the grid settings have been successfully set in *Setup->Grid setup* - Check the AC breaker is ON and that the grid voltage is >184Vac present at the AC terminals - Check that the DC switch is ON and that the DC power is >7W - Restart Inverter (DC and AC) and retry
Self test failure (**W/A – E04**)	For *Italy int SPI* self test: Self test has failed	- Verify if the installation procedure was executed. The grid code should be set to *Italy int SPI* - Verify if the inverter is feeding power to the grid (sufficient irradiation) - Restart the test later
Grid fault (**I/A – E05**)	No detection of the grid, not able to synchronize with the grid or fault when setting the grid-settings	- Verify if the AC circuit breaker is on and operational - Measure that the grid voltage is present at the AC terminals - Check that the DC switch is on and that the DC power is > 7W - Check that the country settings have been successfully set in *Setup>Grid Setup* - Turn the AC 'off' and then 'on'
High DC voltage (**I/A – E07**)	DC voltage threshold of 600 V_{DC} is exceeded	- Fault is cleared automatically when PV voltage reduces below 600V - If the inverter remains in this fault, contact the supplier

Low DC voltage (**I/A – E08**)	DC voltage is too low to operate the inverter	- Fault is cleared automatically when PV voltage exceeds 230V - If the inverter remains in this fault during daylight, contact the supplier
Low PV isolation resistance (**I – E09**	PV isolation resistance is below the permitted level	- Check the complete installation (PV panels, frames, cables, etc.) for areas of low resistance to Earth - The grounding setup is configured incorrectly - Check the jumper for the grounding setup (refer to *4.3.4.7 Jumper Position for System Grounding Setup*)
Inverter DC side failure (**W/A – E10**)	Inverter failure on the DC side	- Failure on the DC side. Other W/A are also shown - If the inverter is in *Shutdown*, turn off the AC side and then the DC side. Wait for 30 seconds, then turn on the AC side and then the DC side - If the fault persists, contact the supplier. Also record the extended status values (see *6.2.2.2 Inverter Status*)
Inverter AC side (**W/A – E11**)	Inverter failure on the AC side	- Failure on the AC side. Other W/A are also shown - If the inverter is in *Shutdown*, turn off the AC side and then the DC side. Wait for 30 seconds, then turn on the AC side and then the DC side - If the fault persists, contact the supplier. Also record the extended status values (see *6.2.2.2 Inverter Status*)
High inverter temperature (**W/A – E12**)	Maximum permissible internal inverter temperature is exceeded	- Check that the ambient temperature is within the specification (Refer to *10 Technical Data*) - Check if the ventilation is sufficient, the minimum distances for cooling are followed and the inverter is shielded from direct sunlight - Clean ventilation (Refer to *8.2.8 Ventilation*)

Current / power limitation (**I – E14**)	PV power exceeds inverter rating	- Input PV power exceeds the normal input levels of the inverter. The inverter will deliver maximum power. - If in shutdown, the inverter will try to start up again when the temperature is within the permissible range again - Check if the ventilation is sufficient, the minimum distances for cooling are followed and the inverter is shielded from direct sunlight - Clean ventilation (Refer to *8.2.8 Ventilation*)
Communication failure (**A – E15**)	Internal communication failure	- If the inverter is in *Shutdown*, turn off the AC side and then the DC side. Wait for 30 seconds, then turn on the AC side and then the DC side - If the fault persists, contact the supplier
Fan failure (**W/A – E16**)	Internal air distribution is missing	- Contact the supplier for a replacement fan
Fuse fault (**A – E17**)	The grounding jumper is in the wrong place, or one or more DC fuses are blown	- The grounding setup is configured incorrectly - Check the jumper for the grounding setup (refer to *4.3.4.7 Jumper Position for System Grounding Setup*) - If the jumper is correctly positioned, contact the supplier - Contact the distributor for replacement fuses
Active power limitation (**I – E18**)	The inverter is in Active power limitation mode.	- No action needed
Reactive power compensation (**I – E19**)	The inverter is in Reactive power compensation mode.	- No action needed

Microprocessor fault (**W/A – E20**)	Grid code not correctly set, or, internal processor fault	- Check the AC breaker is ON and that the grid voltage is >184Vac present at the AC terminals - Check that the DC switch is ON and that the DC power is >7W - Check that the grid settings have been successfully set in *Setup>Grid Setup* - If the inverter is in *Shutdown*, turn off the AC side and then the DC side. Wait for 30 seconds, then turn on the AC side and then the DC side - If the fault persists, contact the supplier
Grid: High AC voltage (**I – E22**)	Too high AC voltage, the inverter stops feeding power	- The inverter will restart when the voltage is within the permissible range - Check that the grid settings have been successfully set in *Setup > Grid Setup* - If the failure persists, contact the supplier
Grid: Low AC voltage (**I – E23**)	Too low AC voltage, the inverter stops feeding power	- The inverter will restart when the voltage is within the permissible range - Check that the grid settings have been successfully set in *Setup > Grid Setup* - If the failure persists, contact the supplier
Grid: High AC frequency (**I – E24**)	The frequency of the grid voltage is above the upper limit	- The inverter tries to restart when the frequency is within the permissible range - Check that the grid settings have been successfully set in *Setup > Grid Setup* - If the failure persists, contact system installer
Grid: Low AC frequency (**I – E25**)	The frequency of the grid voltage is below the lower limit	- The inverter tries to restart when the frequency is within the permissible range - Check that the grid settings have been successfully set in *Setup > Grid Setup* - If the failure persists, contact the supplier

Grid: High output DC current (**I – E26**)	Too high proportion of DC current in the grid feeding	- The inverter tries to restart when the fault is cleared - If the fault still occurs, contact the supplier
Output powerimbalance (**I – E27**)	Imbalance in the output power	- No action needed
Grid fault, still running (**I– E28**)	Fault ride-through	- No action needed
VDR fault DC side (**I – E29**)	The varistors on the DC side are damaged.	- Contact the supplier for new parts
DNO Remote trip (**I – E32**)	Inverter tripped as a result of a command from the DNO	- The DNO must remove the signal before the inverter will restart

***** Reserved for future use

8. MAINTENANCE

This chapter explains how to switch OFF and discharge the inverter safely. It also provides an overview of important regular maintenance procedures to ensure trouble-free operation of the *THEIA HE-t UL* inverters. Finally, it is explained how to remove and return the inverters.

8.1. Switch-OFF

Always turn OFF and disconnect the inverter in the following order prior to maintenance work or repairs:

DANGER

Never perform work on the inverter without disconnecting both the DC and AC side because of deadly voltages present at the terminals.

DC-side

- Turn OFF the DC switch.
- Disconnect the connectors.

AC-side

- Turn OFF the AC circuit breaker(s).
- Let the DC capacitor bank discharge.

WARNING

Lethal voltages may be present inside the inverter after switch OFF, because of a charged capacitor bank. It must be discharged for **1 hour** before performing service or maintenance work on the inverter.

8.2. Regular System Inspections

The *THEIA HE-t UL* inverters are designed and manufactured to operate trouble-free for several years. Performing regular maintenance will ensure high efficiency and a longer service life for the inverter.

NOTICE

Only permit qualified persons to perform the work inside the inverter! Maintenance work involving removal of the inverter's lower cover must be performed by qualified persons only, due to the requirements of the product warranty.

8.2.1. Modules

Maintain the PV modules as recommended from the manufacturer.

8.2.2. Cables

Regularly check all cables inside and outside for signs of thermal and mechanical damage. Replace frayed conductors immediately!

8.2.3. Electrical Connection

Regularly check that the terminals and plugs are firmly tightened, and that the insulation is not deteriorated or corroded. Do not forget the combiner box!

8.2.4. Fuses/Circuit Breakers

Frequently blown fuses or tripped circuit breakers are a clear warning sign of overload, short circuit or ground fault.

- Always determine the reason for blown fuses/tripped circuit breakers prior to replacement/resetting.
- The replacement/resetting must be performed by qualified persons only!

8.2.5. DC Fuses / Ground Fuse

If a DC fuse blows, the following message will appear in the display: "*Fuse fault*" (Refer to *7.2. Table of Events*).

DANGER

The photovoltaic modules (panels) deliver power when exposed to light and produce hazardous voltages, which is still present at the terminal blocks and fuse holders after switch OFF. Do not replace the DC fuses when the PV modules are exposed to light!

Replacement Procedure

- Turn OFF both the AC circuit breaker(s) and DC switch.

DANGER

Always disconnect both the DC and AC sides before opening the inverter's lower cover due to the risk of shock hazards.

- Remove the inverter's lower cover (Refer to *2.4.5. Inverter Enclosure*).
- Check that the terminals are voltage free.
- Always check the cause of the defective fuse prior to replacement.
- **DC Fuses:** Measure the voltage and current: If the voltage is close to or 0 V_{DC} or there is a measurable current do not remove the fuse holder. Recheck wiring for dead shorts or reversed polarity.
- **Ground Fuse:** Measure one string at a time: The voltage between the positive and the ground terminal block, and then the negative terminal and the ground terminal block. Both voltage measurements should be equal to the open circuit voltage (V_{OC}) divided by 2. If the measurements are different, there is a ground fault. Repeat for each string.
- If the voltage and current measurements are correct, remove and replace the defect fuse(s).
- Always exchange the fuses with the same type and rating.

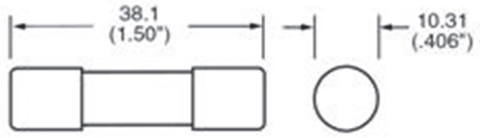


Figure 8.1: Dimensions of the DC fuses/ground fuse

- Make sure that the replaced fuse(s) is completely inserted in the fuse holder, and insert the fuse holder.
- Fasten the inverter lower cover firmly (Refer to *2.4.5. Inverter Enclosure*).
- Turn on the AC circuit breaker(s) and the DC switch.

8.2.6. DC Disconnect Switch

To prevent welding of the contacts, thereby extending service life, the DC switch(es) must be operated at least once every 12 months, preferably at night or when the AC is OFF.

8.2.7. Inverter

The interior of the inverter must be checked by the system installer for humidity and dust every 3 – 4 years.

8.2.8. Ventilation

The heatsink on the backside of the inverter conducts heat away from the electronic components and must be clean to ensure sufficient cooling, thereby preventing yield losses. This is accomplished by using one of the following:

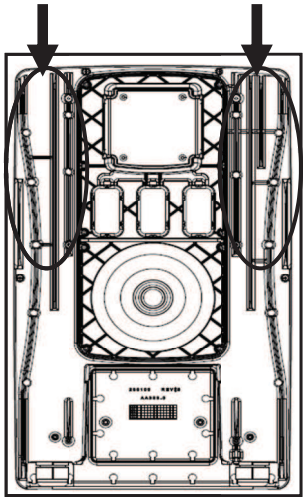


Figure 8.2: Heatsink cleaning

- Vacuum cleaner
- Soft brush
- Compressed air

8.2.9. Fan

The fan circulates the air inside the inverter, which distributes heat and thereby maintains the conversion capacity. The replacement of the fan requires removal of the inverter upper cover and must be performed by ***Eltek*** **authorized service persons only!**

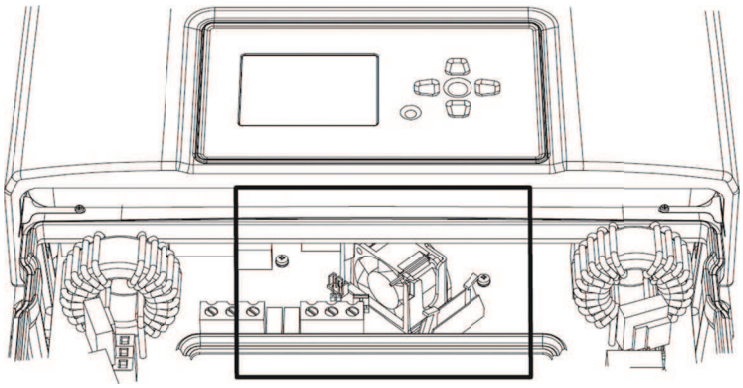


Figure 8.3: Position of the fan

- A message is shown in the display when the fan needs replacement. Refer to *7.2. Table of Events*.
- If the fan fails, the inverter continues to feed the maximum amount of power available until a certain temperature threshold, at which point it starts to reduce power to protect itself against overheating.

8.2.10. Varistors (VDR)

Varistors have a finite life expectancy, and degrade and lose their protective function when exposed to transients. They therefore need regular inspections (every six months). Replacement requires removal of the inverter lower cover and the use of the VDR service tool, and **must be performed by qualified persons only!**

8.2.10.1. DC Side

- A message is shown in the display when a DC varistor needs replacement. Refer to *7.2. Table of Events*.
- Replace the damaged varistor with *DC Varistor Kit* ordered from *Eltek,* part number *271539.*
- The two varistors on the DC side are located on the left side of the inverter lower compartment above the network connections.
- Note the positions of the varistors if they are in need of replacement.

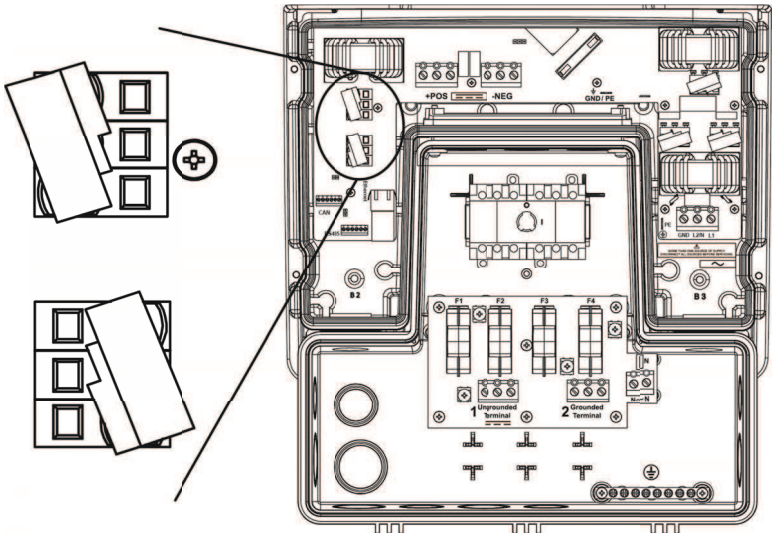


Figure 8.4: Varistors on the DC side

8.2.10.2. AC Side

- No warnings are given regarding the condition of the varistors on the AC side. Therefore, they need to be checked regularly (at least once a year) or after lightning strikes.
- Replace the damaged varistor with *AC Varistor Kit* ordered from *Eltek,* part number *263574.*
- The three varistors on the AC side are located in the right side of the inverter lower compartment above the AC terminal area.
- Note the positions of the varistors if they are in need of replacement.

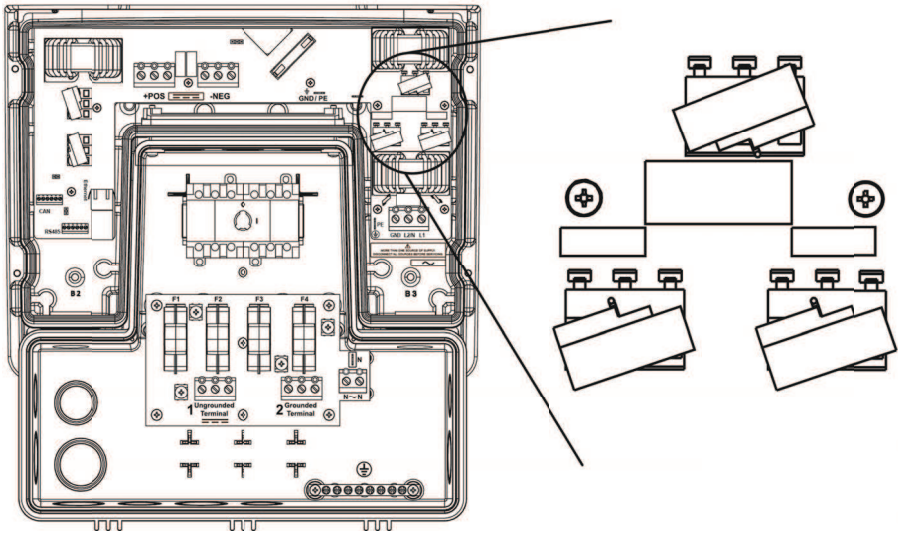


Figure 8.5: Varistors on the AC side

Check of the AC Varistors

Measure the ohms (resistance) between the terminal and the bent pin on each varistor as per the below diagrams:

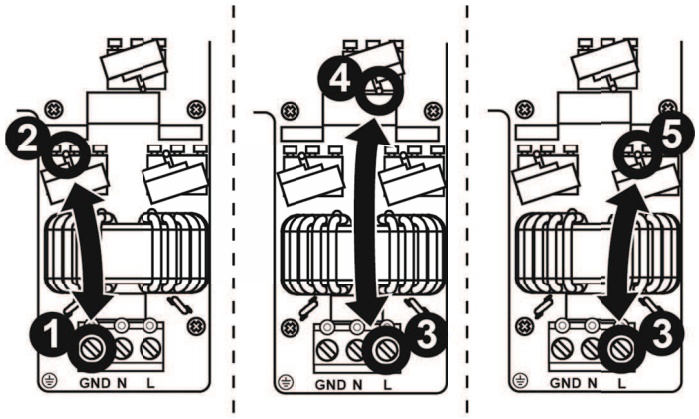


Figure 8.6: Checking the AC varistors

Table 8.1: Check if the varistors are damaged

Measurements	Undamaged	Damaged
Between ***GND*** (1) and the ***left VDR*** (2)	0 Ω	∞ Ω
Between ***L*** (3) and the ***middle VDR*** (4)	0 Ω	∞ Ω
Between ***L*** (3) and the ***right VDR***(5)	0 Ω	∞ Ω

Replacement Procedure

- Use the service tool delivered in the packaging with the new varistors ordered from *Eltek*. The service tool is designed as a fork, and can open up all terminal clamps simultaneously.

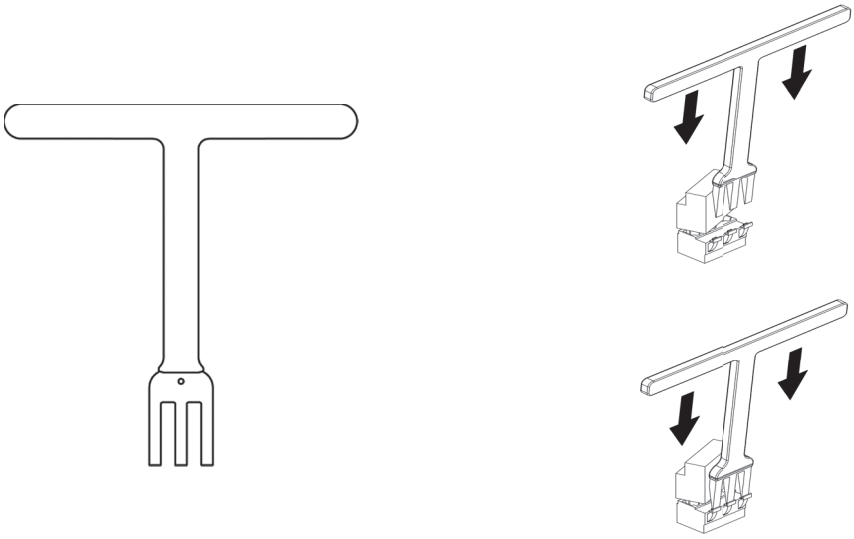


Figure 8.7: Service tool to open the varistor terminal clamps

- Open the terminal clamps and remove the damaged varistor(s).
- Comply with *Figure 8.4* and *Figure 8.5* to get the position of the varistors right.
- Use the service tool to open the clamps when inserting the new varistor(s).

8.3. Replace Devices

The inverter can be replaced without disassembling the Stringbox.

NOTICE

Removal of the inverter's lower cover must be performed by **qualified persons** only!

WARNING

Always disconnect the power sources prior to removal of the lower cover! The inverter is charged with lethal voltages, and removal of the lower cover poses a shock hazard if the inverter is not disconnected.

8.3.1. Dismounting

- Remove the inverter lower cover (Refer to *2.4.5.2 Front Covers*).
- Disconnect both the DC and AC terminals.
- Remove the screws *J* and *K* inside the Stringbox.
- Pull up the fixing plate between the Stringbox and the inverter.
- Pull the inverter up and slide it out of the mounting bracket.

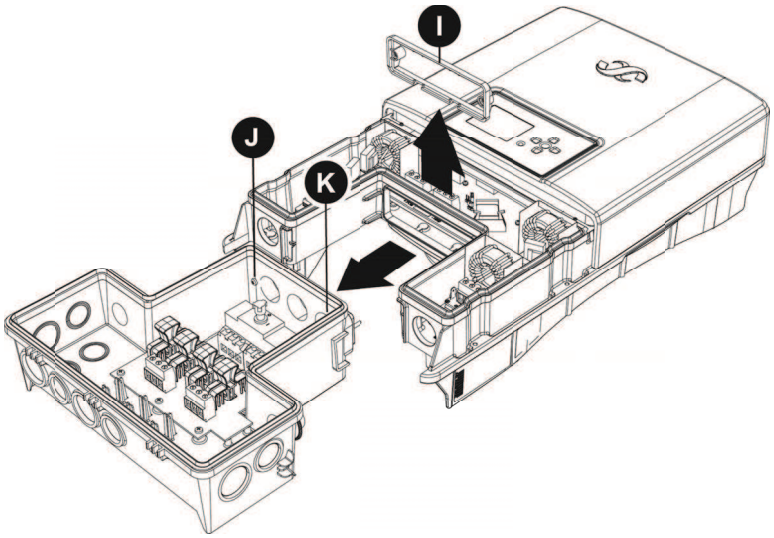


Figure 8.8: Dismounting of the inverter

8.3.2. Replacement

- Slide the new inverter carefully onto the mounting bracket (1 – 2 below). Refer to *4.1.2 Inverter*.
- Check that the connection holes on the inverter (E, F and G below) and on the Stringbox (H) are aligned (3).
- Guide the fixing plate ***I*** into the slot between the inverter and the Stringbox (4).
- Fasten the screws ***J*** and ***K*** with a torque of 1.48 ft-lbf / 2.0 Nm.

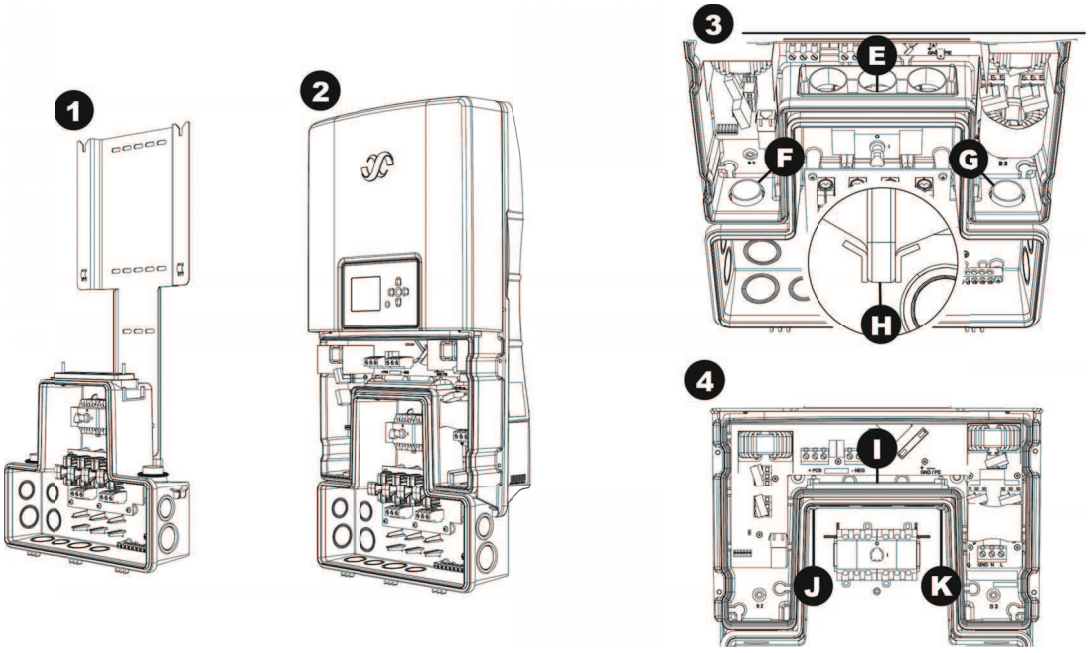


Figure 8.9: Procedure for replacing the inverter

It is possible to add new inverters, or replace existing inverters, in a PV system.

Client

- If the replaced inverter is a *client*, the *master* inverter will automatically identify the replaced device and put it into operation.
- The device number is automatically maintained.

Master

- If the replaced inverter is the *master* and *master* functionality is desired, an existing inverter needs to be set up as *master*. This is done in ***Setup› Network Setup› Set as Master unit***. Select ***YES***, and an automatic logon-sequence is performed.

NOTICE

Removal of the inverter's lower cover must be performed by **qualified persons** only!

WARNING

Always disconnect the power sources prior to removal of the lower cover! The inverter is charged with lethal voltages, and removal of the lower cover poses a shock hazard if the inverter is not disconnected.

8.4. Return and Disposal

When replacing an inverter, it can either be returned to the distributor or disposed according to state and federal regulations. *Eltek* is committed to its policy of environmental responsibility and therefore appeals to end users who are disposing inverters to follow local environmental legislation and to seek safe and responsible means of disposal.

8.4.1. Return

For return to the distributor the inverter should always be in its original packaging or equivalent packaging.

In case of return of the product as a result of inverter failure, a fault report must be submitted to obtain a *Return Material Authorization* (*RMA*) number. The fault report template can be found at: *www.eltek.com/support.*

Prior to Return

- Loosen the locking screws attached to the fixing clip on the mounting bracket.
- Pull the inverter up and out of the bracket.
- Pack the inverter securely in the packaging.
- Add a fault report if relevant.
- Return to the given address in the respective state.

8.4.2. Disposal

In case of return as a result of end of service life, the inverter can be returned to the distributor or disposed in the respective country. Shipping to the distributor is paid by sender.

Recycling and disposal of the *THEIA HE-t UL* inverter must be done according to the rules and regulations applicable in the state of disposal. All material used for the inverter packaging is recyclable.

9. WARRANTY

The inverters are compatible with all relevant standards and are guaranteed to be free of manufacturing defects from the date of purchase. Please refer to the **Warranty documents** on *Eltek's* web site (*www.eltek.com*) for more detailed information about the warranty of the inverter. If any questions, please contact your inverter supplier or the *Eltek* office in your territory.

9.1. Warranty Service

The standard warranty applies for 10 years, with an optional extension of up to 20 years. To maintain the full warranty period, the inverter must be installed within **6 months** after the date of purchase.

NOTICE

To maintain the warranties the inverter must be installed, operated and maintained according to the instructions detailed in this manual and all the applicable local regulations.

9.2. Warranty Disclaimer

The warranty is void by misuse or when unauthorized repairs are performed on the inverter. The warranty does not cover normal wear and tear of the inverter. The warranty is only valid with an identifiable and accepted serial number.

9.2.1. Damage

Eltek takes no responsibility for damages to the inverter due to:

- Unauthorized persons removing the inverter upper cover.
- Unauthorized modifications made to the inverter.
- Inverter installed, commissioned, operated or maintained incorrectly.
- Relevant safety regulations and instructions in this *User Manual* being ignored.
- Inverter operating beyond the limit values given in *10. Technical Data*.
- Inverter exposed to external abnormal conditions such as lightning, storms, fire, vandalism, etc.

Refer to the **Warranty document** for details of benefits and exclusions that may apply to you.

10. TECHNICAL DATA

10.1. Inverter datasheet

INPUT DATA (PV SIDE)		*THEIA 2.0HE-t*	*THEIA 2.9 HE-t*	*THEIA 3.8 HE-t*	*THEIA 4.4 HE-t*
Nominal DC power		2100W	3000W	4000W	4600W
Max recommended PV power		2625W	3750W	5000W	5750W
Max input operating current		9.5A	13.5A	18.0A	21.0A
Max input short circuit		11.5A	16.5A	22.0A	25.0A
Max DC voltage		$600V_{DC}$			
Normal operating range		$230 – 500V_{DC}$			
Number of PV string inputs		3			
Number of MPP trackers		1			
Input features		Reverse polarity protection; Ground fault monitoring; Integral DC switch; Integral DC fuses for string inputs (optional); Field configurable for positive and negative grounded PV strings			
OUTPUT DATA (GRID SIDE)					
Nominal output power		2000W	2900W	3800W	4400W
Max output current		10.0A / 8.5A	14.0A / 12.0A	18.5A / 16.0A	21.5A / 18.5A
AC voltage		208 (+ 29%, - 14%) or $240V_{AC}$ (+ 13 %, - 25 %) single phase			
Mains frequency		55.0 – 63.0 Hz			
Power Factor (Cos Phi)		1			
Inrush current		100 mA (rms), 2 A (peak)			
Max output fault current	value	3.14 A			
	duration	13 ms			
PERFORMANCE DATA					
Maximum efficiency		97.2 %	97.2 %	97.2 %	97.3 %
CEC efficiency		96.8 %	96.8 %	97.0 %	97.0 %
EU efficiency		96.3 %	96.5 %	96.7 %	96.9 %
Power feed starts at		< 7 W			
Night mode power		< 1 W			
Measurements accuracy		AC voltage: ± 2.5V, Frequency: ± 0.1 %, Time: ± 30 ms			
Max utility backfeed to PV		0.0 A			
MECHANICAL DATA					
Protection degree		NEMA 3R or 4X depending upon model			
Dimensions		**H:** 28.35inches/720 mm **W:** 13.9inches/353 mm **D:** 6.5inches/165 mm (6.68 inches/169,5 mm with bracket)			
Weight		<22kg / 49lbs.	<22kg / 49lbs.	<23kg / 51lbs.	23kg / 51lbs.
Cable access		Bottom			
Input cable connection		Conduits and screw terminals, others on request			
Output cable connection		Conduits and screw terminals			
DESIGN STANDARDS					
EM compatibility		EN 61000-6-2, EN 61000-6-3, FCC level B			
CE / UL marking		Yes			
Other standards		UL 1741,IEEE 1547, IEC 61000-3-2/11, IEC 61000-3-3/12			
Safety (protective class)		Class I			
ENVIRONMENTAL DATA					
Operating temperature		-25 to +60 °C / -13 to +140 °F (Possible power derating above +40 °C / +104 °F)			
Storage temperature		-40 to + 80 °C / -40 to +176 °F			
Ventilation		Convection cooling			

ADDITIONAL FEATURES	
Topology	High frequency transformer, galvanic isolation
Noise emission	≤ 37dB
Communication	Graphical, color display with touch sense buttons, 3x LEDs for visual status indication, embedded web-server, Ethernet, CAN bus, RS-485 bus
Warranty	10 years, 15 years, 20 years options

10.2. Field Adjustable Trip Levels

Table 10.1: Continental 208Vac Trip Details

VALUE	DEFAULT SETTING	MIN. LEVEL	MAX. LEVEL	ACCURACY
Vac Overvoltage high trip level	247.1 V	208.0 V	249.6 V	±2.5V
Vac Overvoltage high trip time	120 ms	50 ms	120 ms	±30 ms
Vac Overvoltage low trip level	226.3 V	208.0 V	249.6 V	±2.5V
Vac Overvoltage low trip time	950 ms	50 ms	950 ms	±30 ms
Vac Undervoltage high trip level	185.5 V	180.0 V	208.0 V	±2.5V
Vac Undervoltage high trip time	1.95 s	50 ms	1.95 s	±30 ms
Vac Undervoltage low trip level	106.5 V	104.0 V	208.0 V	±2.5V
Vac Undervoltage low trip time	120 ms	50 ms	120 ms	±30 ms
Vac Over frequency trip level	60.45 Hz	60.00 Hz	63.00 Hz	±0.1%
Vac Over frequency trip time	80 ms	50 ms	80 ms	±30 ms
Vac Under frequency trip level	59.35 Hz	55.00 Hz	60.00 Hz	±0.1%
Vac Under frequency trip time	80 ms	50 ms	80 ms	±30 ms

Table 10.2: Continental 240Vac Trip Details

VALUE	DEFAULT SETTING	MIN. LEVEL	MAX. LEVEL	ACCURACY
Vac Overvoltage high trip level	285.5 V	240.0 V	288.0 V	±2.5V
Vac Overvoltage high trip time	120 ms	50 ms	120 ms	±30 ms
Vac Overvoltage low trip level	261.5 V	240.0 V	270.0 V	±2.5V
Vac Overvoltage low trip time	950 ms	50 ms	950 ms	±30 ms
Vac Undervoltage high trip level	213.7 V	180.0 V	240.0 V	±2.5V
Vac Undervoltage high trip time	1.95 s	50 ms	1.95 s	±30 ms
Vac Undervoltage low trip level	122.5 V	120.0 V	240.0 V	±2.5V
Vac Undervoltage low trip time	120 ms	50 ms	120 ms	±30 ms
Vac Over frequency trip level	60.45 Hz	60.00 Hz	63.00 Hz	±0.1%
Vac Over frequency trip time	80 ms	50 ms	80 ms	±30 ms
Vac Under frequency trip level	59.35 Hz	55.00 Hz	60.00 Hz	±0.1%
Vac Under frequency trip time	80 ms	50 ms	80 ms	±30 ms

ADDENDUM

Due to continuing product improvements and legislation changes, the specification and functionality of the *THEIA HE-t* inverter described in the included documentation may not match the specifications and functionality of the delivered inverter 100%. A typical example is when firmware updates have been applied to the inverter post-manufacture.

Complete inverter user information can be found in the *THEIA HE-t UL User Manual*. The latest version can to be found at *www.eltek.com*.

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